VOLUME LV NUMBER 5 WHOLE 484

SCHOOL SCIENCE AND MATHEMATICS

MAY 1955

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

All matter for publication, including books for review, should be addressed to the editor. Payments and all matter relating to subscriptions, change of address, etc. should be sent to the business manager.

Entered as second class matter December 8, 1932, at Menasha, Wisconsin, under the Act of March 3, 1879. Published Monthly except July, August and September at 450 Ahnaip St., Menasha, Wis. PRICE. Four dollars and fifty cents a year; foreign countries $5.00; current single copies 75 cents.

Contents of previous issues may be found in the Educational Index to Periodicals.

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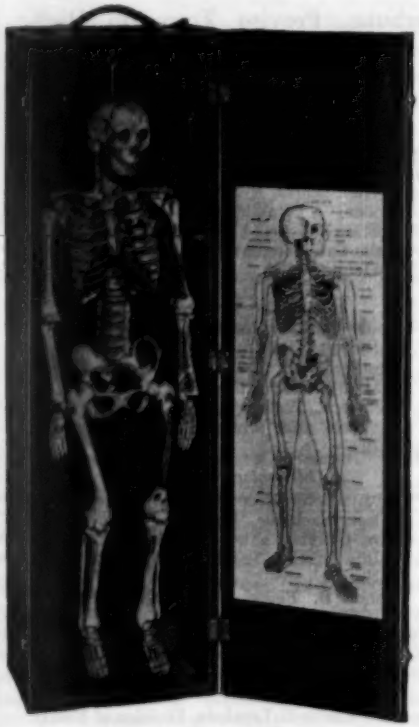

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THE DETECTION OF ATOMIC AND NUCLEAR RADIATIONS*

WARREN J. MCGONNAGLE
Argonne National Laboratory, Lemont, Illinois

When a charged atomic or nuclear particle passes through matter, it causes excitation and ionization of the molecules of the material. The principal methods by which radioactive radiations can be detected and measured depend on their ability to ionize atoms either directly or by means of secondary radiations.

Charged particles produce ionization along their path by the direct action of their electric field on the orbital electrons of the atoms. X-rays and gamma rays do not produce ionization directly. However, when a gamma ray or x-ray is absorbed in matter electrons are ejected from the atoms. The electrons thus ejected have rather high energies and will produce ionization until their energy is expended. Neutrons can only be detected by indirect processes in which they produce ionization. Furthermore, fast neutrons react differently from those of low energy. Fast neutrons can be detected by allowing them to strike hydrogen atoms and then measuring the ionization produced by the recoil protons. Slow neutrons may be measured by a variety of methods, all based on their property of producing disintegration of nuclei with which they react. Boron trifluoride counters are often used. In a boron trifluoride neutron counter boron trifluoride is added to the regular filling gas or a thin coating of boron is applied to the inner surface of the cylinder. Slow neutrons react with the B^{10} isotope according to the reaction ${}_5B^{10}+{}_0n^1\rightarrow{}_3Li^7+{}_2He^4$. The alpha particle produced by the reaction will produce ionization which can then be

* Presented at the Physics Section of the Central Association of Science and Mathematics Teachers at Chicago, November 26, 1954.

measured. If the boron used is enriched in the B^{10} isotope, a substantial increase in sensitivity can be attained. The probability of the above reaction varies inversely with the neutron velocity, consequently the boron-filled counter is not efficient for detecting high speed neutrons.

The cloud chamber was developed in 1911 by C. T. R. Wilson for showing the tracks of ionizing particles. The operation of the cloud chamber is based on the principle that water vapor will not readily condense to form visible droplets unless there is some sort of nuclei on which to collect. Charged particles can act as nuclei for drop formation. Ionizing radiations can be readily identified from their cloud chamber tracks. An alpha particle leaves a short, straight, thick track of dense ionization; a beta particle leaves a thin, irregular and sparsely ionized track. Proton tracks show intermediate characteristics. X-rays and gamma rays can be detected by the secondary electrons which are produced. By counting the number of droplets in a track, the energy of the radiation can be determined.

The photographic emulsion can be used for the detection of nuclear particles. The action of nuclear particles on the silver bromide grains in an emulsion is qualitatively similar to the action of photons but quantitatively different because of the physical characteristics of the particles. When the alpha particle passes through an emulsion containing silver bromide grains, it proceeds in a straight line giving up energy to the grains along its path until it is brought to rest and neutralized. When a photographic emulsion is exposed to an alpha source and then developed, it will show distinct tracks of closely spaced grains. The tracks each produced by a single alpha particle, proceed in a straight line, lie in random directions and end abruptly. In a photograph from a beta source the grains affected by a single particle are more widely spaced since the beta particle passes many grains too rapidly to induce an image on them. Because of the small mass of the beta particle, it is easily deflected by atoms in its path and will not travel in a straight line. The length of a beta particle track through material is much greater than that of an alpha particle. Special photographic emulsions can also be used in recording the tracks of ionizing particles having considerable energy such as cosmic rays. This requires emulsions where chemical fog and other disturbing effects are reduced to a minimum. Since the length of the individual tracks is very short, microscopic examination of the emulsion is required. Using a binocular microscope with a small depth of focus, tracks can be studied in three dimensions.

When a charged particle passes through a gas contained in a chamber across which a small electric field is applied, the primary ions produced will move in opposite directions, each going to the electrode

having the charge of opposite sign. Such a gas filled chamber used for collecting the ions formed by incident ionizing radiation is called an ionization chamber. An ionization chamber consists of a cylindrical conducting shell with an insulated central electrode (see Fig. 1). If an ionization chamber is exposed to a constant source of radiation and the ion current measured for various values of applied voltage, the current increases until a certain value of voltage is reached, after which there is no further increase in current. This current is known as the saturation current and corresponds to the condition where all the ions initially produced travel to their respective electrodes with no recombination of ions taking place. However, if the applied field is increased still more a new phenomenon begins to take place. The primary ions formed by the charged particle pick up enough kinetic energy to produce additional ions before collection at the electrodes.

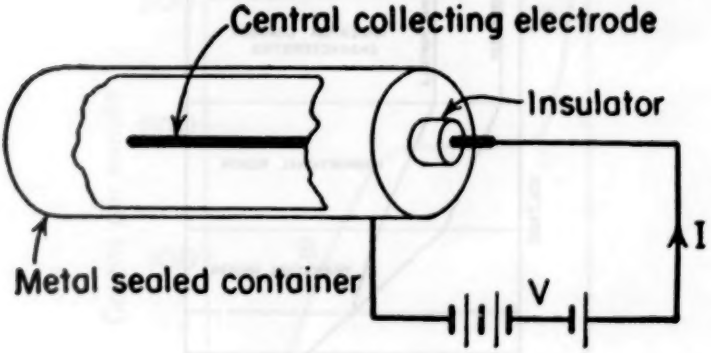


FIG. 1. Ionization Chamber.

The size of the output current pulse is now proportional to the energy of the atomic radiation. Such a chamber is known as a proportional counter.

If the applied field is further increased, so that the production of a single ion pair in the chamber is sufficient to cause a large ionization current pulse to pass, whose magnitude is independent of the initial ionization, the instrument is known as a Geiger-Müller Counter. If the voltage is increased further the counter tube will break into a continuous discharge.

Figure 2 shows the size of the pulse (volts) produced as a function of the voltage applied to the anode of the counter tube. The various characteristic regions of the counter tube are summarized briefly:

1. Ionization-chamber region. In this region the initial ions formed by the ionizing event are collected. At low voltage some of the positive and negative ions formed by an ionizing event recombine, before reaching the anode or cathode, but at higher potentials recombination is negligible.

2. Proportional region. The pulse size produced by an ionizing event is proportional to the initial number of ions formed for any fixed operating voltage.
3. Geiger-Müller transition or limited proportionality region. Pulses are no longer strictly proportional to the energy of the ionizing event.
4. Geiger-Müller region. Each ionizing event produces a discharge in which the pulse size is independent of the number of ions initially produced and the counting rate remains essentially independent of voltage.
5. Continuous-discharge region. This region is characterized by corona, glow, and finally, arc discharge.

In principle all counters are constructed as shown in Fig. 1, but actual designs vary widely depending on the particular type and intensity of radiation to be measured. For example if alpha particles

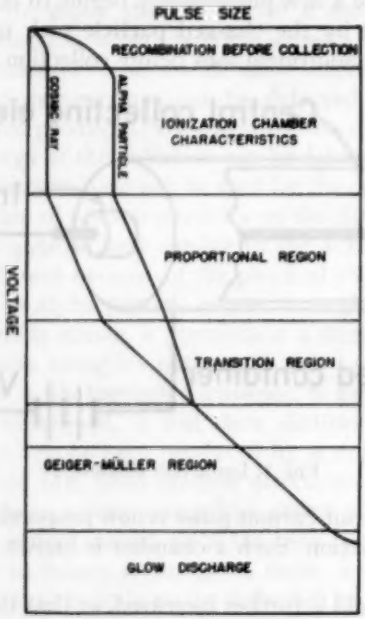


FIG. 2. Operating characteristics of a counter.

are to be measured, it is necessary to use thin sheet mica or stretched nylon films about 0.0001 inch thick for windows. Generally alpha counters operate at atmospheric pressure, and the window is not subjected to a pressure differential.

The Gieger counter exhibits a characteristic curve known as the plateau curve. This is a plot of the counting rate plotted as a function of counter potential with a fixed radioactive source place near the counter. Figure 3 shows a typical plateau curve. Good counters commonly have plateaus 200–400 volts long.

The detection of alpha particles by scintillation phosphors dates back to Crookes and Rutherford. Since the counting of the flashes by the eye was a slow and tedious process, this technique was abandoned in favor of Geiger and proportional counters. The development of the modern photomultiplier has made possible the detection and counting of the light flashes by electronic methods.

The general arrangement of a scintillation counter is shown in Fig. 4. The incident particle or radiation impinges on the phosphor. In traversing the phosphor, the particle to be detected loses its energy in exciting and ionizing the molecules of the phosphor. These molecules then radiate energy in the form of light, some of which falls on the photo-sensitive cathode of the multiplier tube and ejects a number of photo-electrons. These photo-electrons are accelerated by the po-

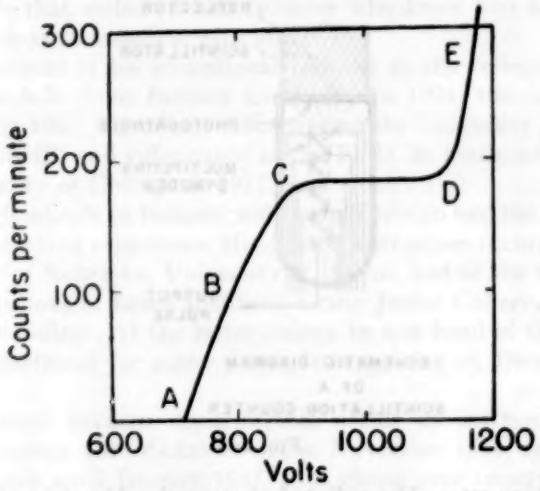


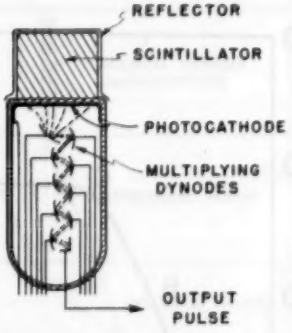
FIG. 3. Geiger plateau.

tential applied between the cathode and the first electrode (or dynode) of the tube. On striking the first dynode, each photo-electron ejects several further electrons by secondary emission. This electron multiplication process is repeated at subsequent dynodes, each of which is at a higher potential than the preceding one. Finally after multiplication of about 10^6 to 10^9 the electron avalanche arrives at the collector plate. It produces a voltage pulse which is applied to an external pulse-recording circuit. Thus the initial energy of a single ionizing particle is transformed into a single voltage pulse, which may be used for detection and measurement. The whole system is enclosed in a light-tight box to eliminate effects other than those due to incident ionizing radiation.

The operation of the scintillation counter can be divided into five distinct, consecutive stages—

(a) The absorption of the incident radiation by the phosphor.
(b) The luminescent conversion of the energy dissipated in the phosphor, and the emission of photons.
(c) The movement of the emitted photons to the cathode of the photo-multiplier.
(d) The absorption of the photons at the cathode, and the emission of the photo-electrons.
(e) The electron multiplication process.

It is desirable to have a large fraction of the energy lost by the particle converted into light energy. The light emitted should be largely concentrated in the region of the maximum spectral sensitivity of the phototube and be emitted in a short time interval to permit



SCHEMATIC DIAGRAM OF A SCINTILLATION COUNTER

FIG. 4.

high counting rates. The radiated photons should not be absorbed in the phosphor. For gamma ray detection the crystal should have a high density and be composed of elements of high atomic number. No one phosphor has all these properties.

The type of measurement and radiation involved will dictate the best phosphor to be used. Alpha particles can be measured simply and adequately with a thin screen of zinc sulfide, silver activated. Gamma and x-rays, beta particles mesons and high energy particles are best detected with either sodium iodide (thallium activated) stilbene, or anthracene. Compared to the Geiger counter, the scintillation counter is faster, and has a greater efficiency for penetrating radiation. For low energy radiations the absence of a window is a distinct advantage.

Certain crystals such as diamond and cadmium sulfide can also be used as radiation detectors. The radiation releases electrons which

move under the action of an electric field and produce more electrons, which in turn give rise to a voltage pulse at the electrodes connected to the crystal.

JACOB M. KINNEY
1877–1955

Those friends of Dr. Kinney who did not know of his passing away on January 19, 1955 will doubtless share his loss to his family, to society, and to the profession with the rest of us who knew him. Born in Spencer, Indiana, on December 21, 1877, he lived a long and productive life that endeared him to those who knew him and whose pleasure it was to associate with him.

Achievements in his educational training at the college level included the A.B. from Indiana University in 1904; the A.M. from Nebraska in 1907; a graduate fellowship at the University of Illinois during 1908–10; and culminated in the Ph.D. in mathematics from the University of Chicago in 1917.

Two high schools in Indiana and two in Chicago had the benefit of his early teaching experience. His college instruction occurred at the University of Nebraska, University of Illinois, and at the three Chicago institutions of Lewis Institute, Crane Junior College, and Wilson Junior College. At the latter college he was head of the mathematics department for many years; later retiring on December 20, 1942.

Dr. Kinney became departmental editor of mathematics for SCHOOL SCIENCE AND MATHEMATICS in November 1924, and continued this work until January 1945, thus giving over twenty years of his out of school time to help mathematics teachers everywhere. His judgment of articles and books was always fair and sound.

Among the professional and educational societies to which he belonged can be listed A.M.S., M.A.A., N.E.A., I.E.A., Men's Mathematics Club of Chicago, N.C.T.M., C.A.S.M.T., and A.A.A.S. Not the least of his professional activities was that of Mathematics Department Editor for SCHOOL SCIENCE AND MATHEMATICS. He is listed in *American Men of Science* and in *Leaders in Education*. He was Vice-President of C.A.S.M.T. in 1937 and a Director 1938–40. His books are titled *Teaching Secondary Mathematics and Survey of Mathematics;* also he joined Dr. Joel S. Georges in authoring the book—*Introductory Mathematical Analysis*.

JOSEPH J. URBANCEK
GLEN W. WARNER

AN ERROR OF OMISSION

The four figures following were omitted in making up the March issue. They should have been included as part of the article, "Mathematics in Elementary Photography," by Robert A. Atkins on page 175 of our March number.

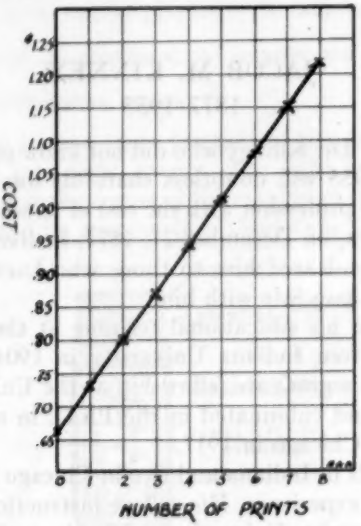


FIG. 1. Cost of film developing.

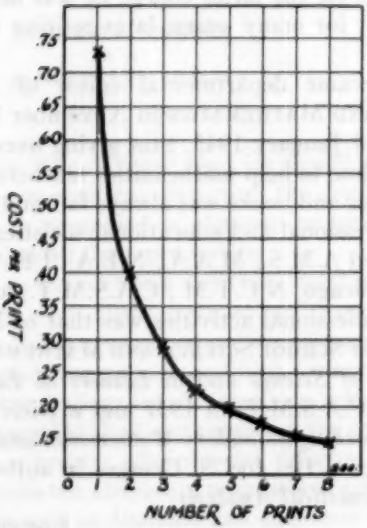


FIG. 2. Cost per print of film developing.

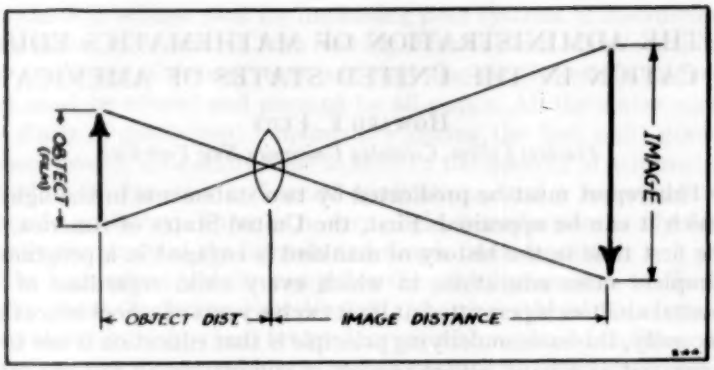


FIG. 3. Path of light rays through a lens.

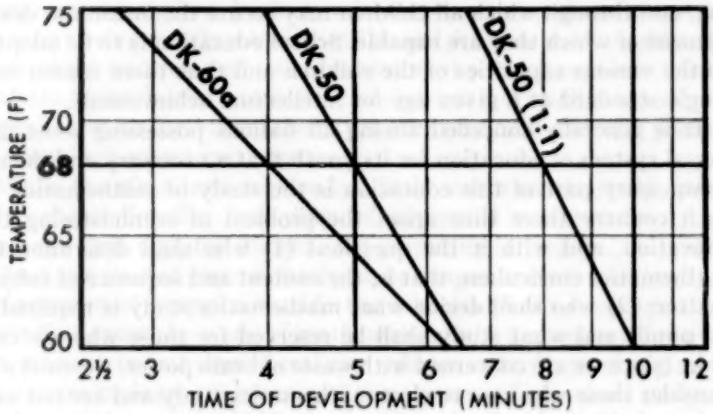


FIG. 4. Time-temperature development graph. (Courtesy of Eastman Kodak Company.)

EUROPEAN STUDY TOUR IN COMPARATIVE EDUCATION

DR. WM. REITZ, *Tour Director*

Wayne University's College of Education again approves credit for the European Study Tour in Comparative Education. Personally conducted by Professor Wm. Reitz, this eighth annual tour will leave Detroit on June 23, 1955 and return September 2, 1955. Qualified persons may earn up to eight hours of graduate or undergraduate credit.

The tour is designed for students, teachers, and professional people interested in the life and culture of Europe. It offers opportunity to survey Europe's educational, social, and civic institutions; confer with the leaders; visit schools and universities; talk with the people; view Europe's famous landmarks such as cathedrals, castles, art galleries; enjoy Europe's gaieties such as plays, operas, and festivals; and absorb the atmosphere of old world cities.

Further details and information may be obtained from Dr. Wm. Reitz, College of Education, Wayne University, Detroit, Michigan.

THE ADMINISTRATION OF MATHEMATICS EDUCATION IN THE UNITED STATES OF AMERICA*

HOWARD F. FEHR
Teachers College, Columbia University New York City

This report must be predicated by two statements in the light of which it can be appraised. First, the United States of America, for the first time in the history of mankind is engaged in a program of complete mass education, in which every child regardless of his mental abilities is permitted at least twelve years of school education. Secondly, the basic underlying principle is that education is not to be conceived as a hard, severe process of eliminating all but the intellectual elite, but as a process that is pleasant, satisfying and rewarding, and through which all children may secure the maximum development of which they are capable. School education is to be adopted to the various capacities of the children and thus there cannot be a single standard at a given age for intellectual achievement.

It is generally conceded among all nations possessing some universal system of education for its youth that a necessary and, hence, compulsory part of this education is the study of mathematics. In each country there thus arises the problem of administering this education, and with it the questions (1) who shall determine the mathematics curriculum, that is, the content and sequence of subject matter; (2) who shall decide what mathematics study is required of all pupils and what study shall be reserved for those who are capable, (since we are concerned with waste of brain power, we must also consider those who care to elect mathematics study and are not capable and those who do not care to study it but are capable); and (3) who shall supervise and examine the results of the teaching of mathematics to insure that desired mathematics is being learned. Only satisfactory solutions to these problems can guarantee to any country sufficient and necessary mathematical literacy for modern life.

In the United States of America there is no direct federal control of education. The control of educational programs is vested in the several state governments, and most of these states delegate to the local city, town, or district the main responsibility of operating their own school program. A local board of education, popularly elected or appointed, selects a superintendent to head the local school system. Here this superintendent is generally responsible for developing and executing a sufficient program of education including the study of mathematics. His program is subject to review and criticism by state officers, but

* Address presented to Section VII, International Congress of Mathematicians at Amsterdam, Netherlands, Sept. 6, 1954.

this check is seldom used for improving poor systems of instruction. Most states have enacted laws making attendance at schools mandatory to the age of sixteen years, and they also specify certain subjects that must be offered and pursued by all pupils. All the states make the study of mathematics mandatory during the first eight grades (school years). This study aims to achieve the mastery of arithmetic, including its business and social applications, and a knowledge of concrete geometry. There is a very slight introduction to algebra, usually the study of the formula and simple linear equation.

The high school usually comprises the school years 9 to 12. In 17 of the states (including New York State), no mathematics study is compulsory in high school for graduation with a general diploma. In the remaining states, with one or two exceptions, only one year of mathematics study is required for graduation. This year of study may be elementary algebra, business arithmetic, or general mathematics, the latter being mostly a review of 7th and 8th year mathematics. In a few of the midwest and southern states, at present over one-fourth of all the high schools (mostly in rural districts and small in number of pupils) offer no further mathematics study beyond this one year of required high school mathematics.

While the state laws require but little mathematics study, most high schools do offer four years of sequential mathematics of an academic type and, for students not preparing for college, they offer at least one year of general, business, or consumer mathematics. It is the pressure of agencies outside the school and the demands they make that cause the study of mathematics to be a necessary elective. For entrance to first class liberal arts colleges and colleges of engineering and technology, a minimum of three years of high school study of mathematics is required. Most scientific schools demand four years of such study. Technical institutes usually demand a year of algebra study and a year of geometry study for entrance. Vocational high schools, under a federal law which grants money to these schools, must give for each of the four years of high school study one hour daily instruction in mathematics related to the shop work.

Business, industry, and civil service more and more are requiring an ability to pass tests in mathematics as a criterion for employment. While these tests are largely on arithmetic skills and problems, they also include elementary algebra and mensurational geometry. This pressure causes most students to elect general, basic, or business mathematics for at least one year of study in the senior high school. Large corporations, such as the General Electric Company, issue literature on the need of mathematics study for employment in their factories. Even though a student does not have to study mathematics to get a high school diploma, he does have to study it to get other than

a menial position upon graduation from school. Those who fail to study mathematics in high school fill our adult evening schools and trade schools trying to make up this deficiency.

Guidance thus becomes a very important aspect of our educational system. The pupil may elect almost as he pleases, but he is more and more being served by expertly trained counselors and guidance officers to elect those studies that will contribute to his future possibilities. In this area of guidance, the large professional organizations of mathematicians and mathematics teachers play an important part in directing mathematics study. The National Council of Teachers of Mathematics, with a membership of over 9000 teachers and 1000 institutions, through its official journal, *The Mathematics Teacher*, its yearbooks now numbering twenty-two, its committees and other publications (including a guidance pamphlet on mathematics study) exerts a tremendous effect on local educational bodies to offer and to require the study of mathematics for at least two of the four high school years, 9 to 12. The other professional scientific organizations support the National Council in all of its endeavors.

The curriculum or body of subject matter is determined for the most part by guides and syllabi prepared by state departments, state committees, local committees, and committees appointed by national organizations. These guides and reports are followed closely by the textbook writers, and thus the textbook becomes the chief tool for determining the mathematics study. Most teacher adhere rigidly to the material and the sequence in the textbook adopted for use. In some states and large cities, a textbook committee examines all textbooks and selects a definite list of three to five books for each year of study. Schools in the state are allowed a choice of any of the books on the list, but they may not use other books. There is a trend away from state adoption to local option. In most schools in the United States today, a teacher or a group of teachers in the local district may select any textbook they deem suitable for their classes.

The only state with a fairly rigid control over the college preparatory program is New York State. This education is supervised by a body called the Regents who, with the aid of teachers in the state, publish a syllabus for each grade, 10, 11, and 12 and administer state-wide tests on these syllabi every year. A Regent's diploma is highly prized and means the individual has met the standards set by the syllabi by passing the Regent's examination. However, as in all the other states, there is local option in each town and village in New York State to give their own courses (approved by the Regents) and to administer their own examinations on these courses. Students receive a local diploma in these cases and not a Regent's diploma.

Iowa is the only other state that administers a state-wide testing

program in mathematics in the secondary school. These tests, however, are not mandatory and are not used to pass of fail students. They provide an overall picture of the mathematical attainment in both the elementary and the secondary schools of the state. Many other school districts use standardized tests with nationally established norms to measure their accomplishment in mathematics against other parts of the country.

In 1900, a group of colleges combined to form a College Entrance Examination Board to administer entrance examinations for college. This Board has grown to a huge testing service today. Over 700 colleges use the examinations of this Board, given several times each year, to determine entrance qualifications of their candidates. The syllabus of this Board and the content of their examinations set a pattern of instruction in most private preparatory schools and in those communities where the high schools emphasize preparation for college. Thus a number of external bodies, through their requirements, exert a real influence in shaping and determining the amount of mathematics study in the schools.

There are several large organizations of schools and colleges, which used to act as certifying bodies, accrediting high schools that met their standards in curricular provisions. These organizations, under a vastly increased high school student body and newer objectives, have changed their function now to that of an evaluating and recommending committee. By an involved system of measurement they determine the offerings and the teaching of mathematics in each system they examine and then recommend changes, additions, and procedures for improving the school system. To be evaluated by such a committee and to receive a satisfactory or high rating carries great prestige value, to such an extent that practically all schools ask for and prepare for these evaluations. This evaluation maintains a highly satisfactory program of mathematics education in those schools which are members of the organizations. (Eastern States and Maryland, Southern Association, North Central Association are the names of some of these evaluating organizations).

Outside of several large cities, there is very little supervision of mathematics teaching. Certification for teaching, a right of the state (which is delegated at times only to cities which desire higher qualifications than those set by the state) demands a certain minimum of collegiate study of mathematics in order to teach mathematics. This varies from 6 hours of collegiate mathematics up to 40 hours of collegiate and graduate study. However, due to scheduling difficulties, much of the teaching of mathematics in schools is done by noncertified teachers. This has resulted in some very poor instruction. In city after city, town after town, each mathematics teacher is his own

authority, selects his own textbooks, teaches what and the way he wants to, and tests his own class as he will. This freedom is excellent for the well-prepared teacher; it is evil for the unprepared or poor teacher.

The overall result, however, has not been too bad. The spirit of free competition between public and private schools, between one community or state and another has produced a fairly good program for average and above average students. Only our gifted children are neglected, and recently a number of innovations have been made to provide a rich program for these students. Through the interchange of ideas, through group and sectional meetings, and through our teacher training and research institutions, we are gaining an acceptance of a broader and increased amount of study of mathematics. As long as we live in a technical, scientific, and statistical age, and as long as our colleges, businesses, industries, and leaders in social, political, and educational thought continue to make demands for mathematics education, the schools will administer and improve such education.

WORKSHOP IN SCIENCE

UNIVERSITY OF WISCONSIN
SUMMER, 1955
Educ. 237A—4 Weeks—July 5 to 29
(3 graduate credits, Fee $35)
Profs. Davis, Pella and assistants

The Problem for the Workshop

"How to Organize and Teach a Continuous Program in Science for Grades 1 to 12 Inclusive"

It is hoped that school systems will send one or more teachers to work in each of the three levels—the elementary school, the junior high school and the senior high school. If it is not possible to send teachers to work in all three levels, a group can work in one or two levels.

We feel this Workshop will provide a worthwhile experience for teachers because they will be able to get ideas, plans, and information from several other groups. Possibly some schools will be able to defray part or all of the expenses of the teachers who participate in the Workshop.

There is a very serious shortage of scientists as teachers, technicians, engineers and other professions. In 1955 there will be only enough college graduates to supply fifty per cent of the demand. We need a continuous program in science to not only supply more scientists but also to speed up the program so the length of the professional training may be decreased, or at least not increased. The available knowledge in the natural sciences is increasing so rapidly that a continuous program is needed to help pupils prepare themselves for all kinds of technical training as well as to be prepared for activities which do not require college training.

We would like to have the names of teachers who will be members of the Workshop as soon as possible. This will give us the opportunity to make plans so that each group of teachers will be able to get started on their problems the first day or two.

Send names of teachers to Ira C. Davis, Education Building, University of Wisconsin, Madison.

DEVELOPING A SOUND SCIENCE PROGRAM FOR ELEMENTARY AND JUNIOR HIGH GRADES

RICHARD G. TELFER
Kalamazoo Public Schools, Kalamazoo, Michigan

INTRODUCTION

Most of the cities and towns of America have a place for science in their public-school curricula. This is eminently reasonable since it has long been realized that youth must be trained to recognize, meet and carry out the needs of a fast-moving world that is becoming steadily more scientific in nature. A causal survey will indicate, however, that these cities and towns do not follow the same standard program in science as they may in mathematics or English. The reason is that these other fields of learning have become more or less stabilized from one geographical area to another. Similiarly no standard program of science supervision has been established that serves as a pattern for these various communities. It would seem, however, despite these regional differences that any large city attempting to develop an integrated program of science would have to consider the same factors, namely (1) purpose of the program, (2) implementation of the program, (3) instructional materials, and (4) supervisory activities.

The ensuring discussion will explain how some of these factors have been considered in the public schools of Kalamazoo, in hopes that other schools may be able to profit from their experience, even if only a little.

PURPOSE OF THE PROGRAM

Basically, the chief goal of education is to help the child learn so that he may be a successful citizen of his community. Recently much stress has been placed on providing buildings and equipment for the expanding school population until in many communities people have forgotten that the goal is not providing buildings, but training youth to be effective citizens. Naturally buildings are important, but they cannot compensate for a weak instructional program.

What then should be done in the elementary and junior-high-school grades with respect to providing an effective program in science? At the elementary level subject matter is far less important than is the training the child is to gain in the skills of science. The training should encompass skills such as observation, recognition of change of environment, learning differences and similarities among natural phenomena, and drawing conclusions.

On the junior-high-school level the science program may be approached more from the subject matter viewpoint. Assuming that the skills and attitudes have been established in the early grades, the

junior-high-school teacher may use them in a more detailed study of subject matter. The following curricular pattern has been suggested for Kalamazoo, all elements of which seem to be consistent with the present trend toward the general education philosophy of science.

I. At the Elementary level—Elementary Science
  A. A series of units would be prepared for each grade.
    1. Units should be self contained, to enable the teacher to use subject matter with which she is most familiar to teach skills, attitudes and techniques.
    2. The teacher should select the suitable units from the ones prepared.
  B. Articulate skills and attitudes of science from grade level to grade level rather than subject matter.
II. Junior High—grades 7 and 8—General Science
  A. The age of learning to deal with the abstract.
  B. Subject matter may be emphasized to a greater degree.
    1. Skills have already been developed.
    2. Teachers are usually better trained in the science area.
III. 9th Grade—General Biology
IV. 10th Grade—General Physical Science

Depending on the needs of the school specialized courses in chemistry, physics, advanced biology and earth science may be used as capstones to the general education program.

It is a foregone conclusion of course that teachers should be capable of handling with success those subjects and duties assigned to them. At the elementary level a common problem is the one of teacher competency with respect to science. Ordinarily the elementary teacher is well trained in English, arithmetic, reading and spelling. However studies show that they have not had opportunity to experience the many areas included in science. Yet these same people are expected to teach science subjects with the same success as they do subjects in which they are generally competent. Interviews with several elementary teachers who teach science indicate that many feel insecure in certain areas of elementary science. Hence they tend to stress their strong areas in their teaching. In Kalamazoo the plan suggested depends on subject matter only in so far as it promotes the development of skills and attitudes. Hence the self-contained subject matter units enable the teacher to select those with which he or she is most familair and to use them to develop these skills and attitudes.

Implementation of Proposed Program

The term "implementation" refers to the process by which a program is put into operation. There are two methods for such implementation. One involves the science committee; the other, a science supervisor or coordinator. The function of the latter will be discussed later.

What then is the function of the science committee? In Kalamazoo it is composed of a teacher from each building within the school sys-

tem who teaches science sometime during the school day. In addition the committee invites special resource persons who are available to give help when it is needed.

Obviously to work effectively it is important that each member of the science committee understand the entire program of science. Since each is responsible for interpreting the entire science program to the staff in his building. Part of the work of the committee has been devoted to producing a resource guide and other instructional materials.

The problem of the resource guide confronted the sceince committee in Kalamazoo early. The committee accepted the task of preparing them for each level, following a spiral plan of learning. In order to assure their effective use it was decided to work through the sub-chairman as to problems of presentation, and answering questions from teachers. Reports are then presented to the entire committee at its monthly meetings. Suggestions for improvement of the program are then forthcoming and discussed before the entire committee. In this way the plan is developing and is becoming effective in reaching the basic goal of the science program.

Instructional Materials

The materials contained in a resource guide such as that of Kalamazoo, are of primary importance. Such a guide should include the following:

1. The goals of the science program
2. Suggestions for use of the guide
3. Basic equipment needed for demonstration and experimentation
4. Film references
5. Text references
6. Suggested topics of study
7. Suggested activities to use for a given topic
8. Data on how guide was built

The guide should be fastened together in such a way that new pages may be added without difficulty. This allows for changes that may be needed in the guide. Further it should be constructed on a grade-level basis so the teacher needs only to consult the section of direct importance for her grade.

Building a guide is of course not an easy task. The science committee in Kalamazoo has worked three years thus far. Many meetings were held at which an outside consultant in science ws called for help. Other meetings were spent in previewing films and in actual production work.

The guide for the Kalamazoo science program contains eight "major" or "constant" areas for each grade level. Obviously it would be desirable for each child to receive experiences in all these areas but

for reasons already given it is unlikely that he will. Naturally the constants are handled differently each year. This allows for a spiral plan of learning whereby these areas will be developed partially each year in which the child has science.

It is well to encourage teachers to deal with as many of the constant areas as possible. However, it should not be a requirement that every teacher teach all of them. This will eliminate the feeling of insecurity on the part of many. Further the laws of chance will likely assure that during the years the child has science each of the constant areas will be handled by some of the teachers in the school system. This situation is not so urgent at the junior-high-school level since most of the teachers of science have wider backgrounds in that field.

In brief, the resource guide is a reservoir of instructional material to aid the teacher. It should not be confused with the rigid course of study programs that have been forced on the teacher in many school systems. The guide allows for a flexible type program that can best meet the needs of the child.

Supervisory Activities

It is essential that there be a leader for any program undertaken in the school system. In the area of science it is most essential since many problems in this area are unique and demand specialized help. Hence a science supervisor may be of greet value.

The term "supervisor" often has an unpleasant connotation, namely that of "dictator" or boss". No program, however sound in structure, can function with the proper effectiveness with this feeling present in the teachers. The term "coordinator" or "consultant" is probably better.

A survey of several school systems was conducted concerning the problem of consultants. The questions asked were these: (1) Does your school system have a person supervising the science program? (2) If not, what do you believe such a person should be expected to do if one were hired? A few of the responses follow:

D. K. Stewart—Coordinator of Elementary Education—Iowa City, Iowa.
Suggests that a person doing supervisory work in science would have added problems because of materials etc. and would unlike other supervisors need to possess specific skills in the field of science.

N. G. Fawcett—Superintendent—Columbus, Ohio.
Supervision of science throughout the school should be handled by a person with a knowledge of the general education program with sufficient ability to see science education in its proper place.

R. L. Springer—Coordinator Elementary Education—Indianapolis, Ind.
A science supervisor would preform duties similar to those entitled Consultant Services. Consultants do not, as was in the past evaluate teachers, but rather serve to help teachers.

J. H. Erwin—Deputy Superintendent—Niagara Falls, New York.
The supervisor shall recommend materials, shall work with principals but will refrain from doing administrative work.

The responses from the educators just mentioned give some suggestions as to what the general functions of coordinator might be. It should of course be realized that every school system would have peculiar problems involving such a leader. Assuming the problems of Kalamazoo are typical these suggestions are offered.

The coordinator should:

1. Work in close cooperation with entire administrative and supervisory staff. Understand the broad school problems and consider science as a part of the whole.
2. Help orient new teachers to the system, especially those in his department. Be on hand to answer questions, explain policy and in general give a helping hand if needed.
3. Work with All City Science Committee in developing and furthering the use of the resource guide. This should not be a directed type function but rather helping, working with.
4. Provide opportunities for visitation by teachers to classes of other teachers for portions of a day.
5. Act as a supply agent for science department by helping teachers with orders, selection of proper items (especially in elementary area); getting a balanced division of equipment across the city. Submit orders from best sources to purchasing agent.
6. Evaluate audio-visual materials for science. Help select new materials. Work with teachers in preparing audio-visual needs, coordinate with audio-visual director.
7. Be available to do demonstration teaching where requested by a specific teacher who believes that he or she might benefit from the experience.
8. Be available to discuss any problems that a principal might have with respect to science in his building, whether it be about size of classes, teacher supervision or school supply.
9. Issue a bulletin for all teachers of science that would list new publications, free materials, new equipment, techniques being tried by other, and any other data that might be of value for helping teachers.
10. Keep up to date on new trends in education and guide the science program in the most up to date direction.

The preceding duties are not all the duties of the science coordinator but rather a basic set from which many others may be derived. It would seem that any duties beyond these would develop from the situation confronting the science program in a particular school.

Summary

To be effective in providing a better science program the plan suggested must be supported by the entire faculty. The aid offered by the science committee, the resource guide, and the coordinator are of little value if it is not acceptable to the staff. It is essential that a complete understanding of the function and purpose of this plan be explained and discussed before it is installed in the system.

THE IOWA TEACHERS CONSERVATION CAMP: ITS PHILOSOPHY AND CURRICULUM*

H. SEYMOUR FOWLER
Iowa State Teachers College, Cedar Falls, Iowa

The staff of the Iowa Teachers Conservation Camp believes that an individual becomes interested in conserving resources only when he has an acquaintance with the resources and an understanding of them. Also, an understanding of the interdependence and interrelationships of the resources must be developed. Since these are basic hypotheses in our Camp philosophy; we consider an understanding of ecology a concept of prime importance in camp teaching. The Camp program also stresses "learning-by-doing" as opposed to vicarious experience. In addition, we feel that the proper laboratory for the "learning-by-doing" experiences is the out-of-doors where one finds the resources in their natural setting. We should also mention that we believe teachers need the "know how" as well as the "know what" to teach. So we spend some time in demonstrating simple activities which the teacher will find useful in her elementary or secondary school classroom. Also appropriate visual and auditory aids are presented as a part of the Camp program. Teachers are given a wide variety of free printed materials on conservation made available by State and Federal agencies and by industrial concerns.

Perhaps an examination of the two courses presented at Camp would give the best evidence of the philosophy and its application.

Students attending camp are for the most part teachers-in-service. Each teacher receives five quarter hours of college credit for the successful completion of a three-weeks session at Camp. Many come to gain credits for renewal of teaching certificates. Many others come with an enthusiasm for conservation. We believe that it can be safely said that most of our teachers leave Camp with an enthusiasm for doing a better job in teaching conservation and with an awareness that they play an important role in the future of any conservation movement.

Camp sessions begin on a Sunday evening and continue through to Saturday noon during each of three weeks. In general each day's program may be divided as follows: Morning Session, 8:00 A.M. to 11:30 A.M., Field work; Afternoon Session, 1:00 P.M. to 4:00 P.M., Discussion of Morning Experience plus applications to teaching; Evening Sessions, 7:00 P.M. to 9:00 P.M., Audio-visual aids plus preview of next days experience. Also two early morning bird-hikes are scheduled each week. These begin at 5:30 A.M.

* Presented at the Central Association of Science and Mathematics Teachers, Conservation Group, at Chicago, November 27, 1954.

One three-weeks sessions is devoted to a study of soils, water, and forests. When the conservation of soils is the topic for study, the group takes several field trips to become acquainted with the bedrock formations and the glacial drift sheets of Iowa. This provides a background for understanding that soils are formed in large part from weathered and decomposed rocks. In addition, the teachers learn field trip techniques during these early excursions. Next, the soil itself is examined to see and feel the difference in the physical structure of some of the various soil types in Iowa. A soil scientist from the U. S. Department of Agriculture and an agronomist from Iowa State College take the campers to adjoining counties to observe several different soil associations. Then comes a trip to a farm operated under U. S. Soil Conservation Service recommendations where grassed waterways, contour farming, terracing, and strip cropping can be observed. The teachers also learn how soils are tested how soil profiles are made, how soil maps are used, and how soil nutrients are supplied.

During the course of the three weeks sessions, the campers become accquainted with many resource leaders from various conservation organizations. They learn how these resource personnel can be contacted and used in their local schools. Mimeographed lists of conservation organizations which can be called upon to supply resource leaders are distributed.

The second week of the soils-water-forests session is devoted to a study of forests as a resource. Campers learn to identify a selected number of common forest trees. Each camper makes a leaf collection appropriate for use in her classroom. The students are introduced to woodlot management problems and to the work of the Iowa Farm Foresters, employees of the State Conservation Commission. The visiting Farm Foresters discuss the status of woodlot management in Iowa and the value of windbreaks. For this portion of the course, campers again are in the field. During a trip to a managed woodlot, the Farm Foresters give demonstrations of techniques and exhibit equipment used in woodlot management. Campers learn how to determine the height and diameter of trees by actually measuring these quantities with the use of cruising sticks. The cruising sticks are constructed by the campers. A trip is made to a farm-sawmill where the students see a small sawmill in operation.

The next activity during the week in which forests are studied consists of an ecological study of a forest community. During this forest trip, campers learn ways in which forests may be managed to encourage wildlife. Later in the week campers visit a woodlot in which grazing is practiced and also an adjoining woodlot in which no grazing is allowed. From this experience, the students receive first-hand in-

formation on the detrimental effects of grazing a farm woodlot. In addition windbreak plantings are examined and a visit is made to a commercial saw-mill. Another stop on the itinerary for the forests week is the State Forest Nursery. Campers are also given instruction in tree planting. As was the case during soils weeks, the campers are again acquainted with a large number of resource leaders who give excellent, authoritative treatments to the subject. We feel that the use of a large number of visiting resource leaders adds a great deal to the success of the Iowa Teachers Conservation Camp.

The topic for consideration during the third week of the soils-water-forests session is water as a resource. Campers study water as a habitat for plants and animals. During a field trip to a lake they do some seining. With the help of a visiting specialist they learn to identify some of the common fishes in Iowa. A trip to a typical Iowa marsh gives the campers an introduction to marsh vegetation and its associated animal life. Marsh-management problems are discussed and illustrated during the trip. The campers are introduced to five Conservation Officers who were formerly called game wardens. The Officers accompany the campers to a stream where they demonstrate legal and illegal fishing and trapping procedures. A session on fly-casting and bait-casting is a popular portion of the Officer's presentation.

Later in the week the campers visit the Little Sioux Flood Control project. This trip entails a journey of two hundred and fifty miles. During the day's journey the campers examine numerous flood control structures. They gain first-hand information from the men who manage the flood control project, as to just what is involved in an attempt to control and manage a watershed area where flooding has been an annual occurrence. A visit to a State-owned fish hatchery is also a part of the day's activities.

Stream pollution is a problem in Iowa. We feel that our campers should be aware of ways in which municipalities may help to control the amount of pollution dumped into streams. To demonstrate how one small municipality works in this direction we visit a modern sewage treatment plant.

A portion of each week's program is devoted to a discussion of curriculum applications. During these periods the camp staff attempts to illustrate ways in which the content of the week's sessions may be adapted to the program of the public schools.

A second three weeks session at Camp is devoted to a study of: Soil Nutrients, The Balance-in-Nature, and Wildlife. During this course the same pattern of first-hand experiences with resources is followed. We again invite in a large number of resource leaders to assist with instruction. As was the case in the other course, field

experience is the teaching technique employed. Appropriate visual aids are introduced and the "knowhow of the public school classroom" is given attention.

During the first week of this session we deal with soil nutrients. An Extension Agronomist from Iowa State College introduces the work that deals with soil formation, texture, profile and types. A trip to the field crops experimental plots at Iowa State Colleges gives the campers first-hand evidence of the effects of certain nutrients on crops. Campers also learn how to take soil samples. The effect of chemical fertilizers and organic matter on soils is discussed. The effects of soil fertility on animal nutrition is also brought out as is the relation of soil fertility to human nutrition. During this portion of the work, the campers are introduced to an Extension Nutritionist who assists with instruction.

The study of Wildlife and the Balance-in-Nature completes the three week session. During the latter two weeks of the session these two topics are treated. To accomplish the objectives for these units of work, the campers again take to the field. A field trip to study birds, their nesting habits and adaptations introduces the two weeks work, The campers are also given an opportunity to visit the state Conservation Commission's Traveling Wildlife Exhibit. This "zoo-on-wheels" contains living specimens of Iowa wild animals. In addition a study of Iowa Game Birds is made. The campers also learn how to develop wildlife areas by actually mapping an area and developing recommendations for plantings in the area. The mammals of Iowa also are topics for study. As in other topics the field trip is used as the teaching procedure. Next, our program treats the fishes of Iowa. Campers make excursions to a stream, to a lake and to a river and study the representative forms of life in each. Food chains also come in for discussion. Physico-chemical factors such as temperature, turbidity, and available oxygen are investigated in the aquatic habitats. A similar study of terrestrial habitats is undertaken. In this case the physico-chemical factors and living things in a woodland, woodland edge, open field and roadside area are studied. A field trip from the lake shore of Springbrook Lake up to an upland timber association helps to develop the concepts of plant and animal succession.

During the period of the three-weeks session just described, each student undertakes what the staff labels as an "Individual Observational Study." Each camper chooses a small area on which the study is made. During the period, campers attempt to observe changes in the habitat. Another popular study is that of field observations of a particular species such as a song bird. The nesting habits of a bird have been popular also. Some campers have trapped small mammals

in a limited area. Plant galls, spider webs, aquatic insect larvae, and other species of insects are subjects for investigation by some students. Each student is given an opportunity to present an oral report on his investigation.

The Iowa Teachers Conservation Camp completed its fifth year of successful "down-to-earth" training in conservation during the summer of 1954. In those five years many Iowa teachers have had an opportunity to build a background in conservation at Camp. Many of the teachers have been extremely successful in carrying back to Iowa schools their experiences at Camp. This is the manner in which the Camp training pays dividends since those who are public school students today become land owners and voting citizens tomorrow.

ACTIVITIES OF THE IOWA TEACHERS CONSERVATION CAMP (PART TWO)*

GEORGE W. WORLEY
Iowa State Conservation Commission, Iowa City, Iowa

Dr. Fowler has told you about the curriculum offered at the Iowa Teachers Conservation Camp and the philosophy behind its organization. The curriculum is the core around which the camp is built. Through the course of study, field trips, and activities we try to provide accurate, up-to-date, pertinent information about our natural resources and their conservation, and we try to suggest interesting, practical methods of teaching this information.

The curriculum is basic. We believe that, although not perfect, it is a good curriculum. It has evolved through trail and error, and has benefited much from the experiences and advice of other camp staffs. Curriculum, however, is not by itself the secret of the success of the camp. There are several other factors which we believe have been of considerable importance in making the camp such a powerful influence in conservation education in Iowa.

Some of these factors are physical in nature. I will mention one example and others will be suggested and illustrated in the movie on the camp you will see in a few minutes. The fact that Springbrook State Park where the camp is located is at the precise edge of the Wisconsion drift area has made it easy to bring geological history to life. We talk about it and at the same time find dramatic evidence at our feet and all around us. This initial experience at the camp has stuck in the minds of teachers more than perhaps any other. Thus,

* Presented at the Central Association of Science and Mathematics Teachers, Conservation Group, at Chicago, November 27, 1954.

location of the camp, combined with superb instruction by a visiting specialist, is a prime factor in getting each camp session off to a memorable start.

Sharing with 30 to 50 other teachers the experience of living together in a camp situation has had a terrific impact on the attitudes and learning processes of campers. Living in a camp situation is unique, even new, to most of them. Experiences while at camp are not soon forgotten, and the staff makes it their job to see that whenever possible experiences at camp have a conservation connotation. The spontaneous development of a strong "camp spirit" is unobtrusively but positively encouraged by the staff. Campfires, games, sings, ice cream treats, and similar camp activities encourage unification into a group of teachers who almost literally eat, sleep, think, and talk conservation 12 to 16 hours a day for 3 weeks. The result is the association of conservation with a pleasant and unique experience. Conservation camp is to many a milestone in their lives. Obviously, what was learned at camp is well remembered and practiced.

Every effort is made to maintain the camp spirit after teachers leave camp. At every opportunity throughout the year, teachers are reminded of their days and nights at Iowa Teachers Conservation Camp. They are reminded of their obligation to teach conservation persistently and well. About 4 times a year a camp magazine, "The Voice of The Turtle" is sent to all former campers and to many others who have an interest in conservation education in the state. The "Voice Of The Turtle" contains news of campers, plans for future sessions, camp songs, poems, jokes, notices of new teaching aids, films, publications, demonstrations and activities, etc. It is a magazine on conservation education in Iowa.

Attractive gold and enamel pins in the shape of the cartoon turtle camp mascot are sold at cost to campers as souvenirs of camp and to create interest wherever they are worn.

Each year a booth at the Iowa State Teachers Convention serves as convention headquarters for former campers. Brochures on the camp are distributed, as well as other conservation literature. Camp spirit is renewed. A camp reunion and breakfast is held. Campers and former instructors seldom miss the camp breakfast if it is at all possible to attend. Many bring guests which almost invariably are so impressed by the informality and spirit that they show up at camp the next summer.

Campers are encouraged to advertise the camp whenever possible. Sets of kodachrome slides taken during the session they attended are made available to former campers. The same film you will soon see is available to them for showing to fellow teachers, local civic groups, clubs and other groups. Their efforts do more than encourage new

campers. As they sell the camp their own interest and enthusiasm for conservation teaching is renewed.

Staff and visiting specialists help in the "follow-up" activity whenever possible. While on extension or in their normal field activities they take advantage of every opportunity to contact former campers and maintain their interest and remind them of their responsibility to conservation education. Former campers and potential campers are contacted several times a year by personal or form letter in connection with announcements of conservation meetings, special developments in conservation education, or other professional matters. A mailing list of all former campers is on addressograph stencil plates to expedite special mailings.

The "follow-up" program carried on in connection with the Iowa Teachers Conservation Camp is, I believe, unique among conservation camps. We believe that this program is a major factor in increasing the effectiveness and in stimulating use of the training offered at ITCC.

There is another aspect of the Teachers Conservation Camp program which we believe has had a significant effect on both teachers and the total conservation education picture in Iowa. This is the drawing into a single cooperative project of a large number of agencies and persons which had never before worked together to such a degree.

The conservation camp began primarily as a cooperative project of three state agencies—Iowa State Teachers College, the State Department of Public Instruction, and the State Conservation Commission. They were not alone for long. Since instruction was to be primarily by visiting specialists, other agencies which provide these specialists were called in. The U. S. Soil Conservation Service, Extension Service, Iowa State College, and others were soon deeply involved in planning sessions. When the need arose for advertising brochures there was at the time no provision for such expenditures by state agencies. The Iowa Division of the Izaak Walton League came to the rescue and paid the entire cost of printing the brochures. The following year the same problem was solved by some 30 Izaak Walton League Chapters, independent sportsmen's clubs, and other local groups who chipped in to raise over $400 to pay for printing the brochure "Why Iowa Teachers Leave Home." The Federated Garden Clubs of Iowa have given generously of their funds and their support to buy equipment for the camp and furnish scholarship assistance to teachers.

The suggestion was made in 1953 that sportsmens clubs, garden clubs, Soil Conservation Districts, and civic and industrial groups give scholarship assistance to local teachers interested in attending

the camp. The response was immediate and impressive. Participation in the "sponsor a teacher" project grew until, in 1954, 76 teachers enjoyed assistance from local groups.

The new Iowa affiliate of the National Wildlife Federation (The All-Iowa Conservation Council) as one of its first projects sponsored a fellowship enabling a former camper to do research on the use and effectiveness of training offered at the camp. The resulting thesis "A Study of Conservation Education Presented At The Iowa Teachers Conservation Camp From 1950 Through 1953" by Miss Novella Bredbenner, will be published and distributed by the Conservation Commission. The following year the All-Iowa Council helped secure and administer a grant-in-aid from the National Wildlife Federation which provided scholarships for 16 teachers to attend the camp.

The State Planning Committee which guides the Conservation Camp consists of representatives from nearly all agencies and groups interested in conservation. Because of its composition this committee has naturally assumed leadership in the promotion of conservation education activities not specifically connected with the Camp.

All the above examples of cooperation are intended to emphasize one point. The Iowa Teachers Conservation Camp is not the work of two or three state agencies. It is a state-wide project. Nearly every organization in the state with even a remote connection with conservation is involved in the camp to some degree. Literally thousands of people contribute to it in literally hundreds of ways. The benefits are as widespread as the participation. The teacher who comes to camp on a scholarship benefits from the training she receives. She feels an obligation to the club or group who helped to pay her way. She owes them a better job of teaching conservation in *their* community. They take pride in her success and effectiveness, for *they* helped make it possible.

No matter what the degree of participation, all who are in any way associated with the camp are more conscious of conservation and natural resources involved. Who can measure the long-term effect of the often thin but far-flung threads of the conservation camp spirit.

Curriculum and activities truly are the meat of the Iowa Teachers Conservation Camp or any conservation camp in any state; but camp spirit, follow-up, and the cooperative nature of the whole project may in the end be equally significant in molding the conservation attitudes and philosophy of Americans now and in the future.

Drawing pen with push button automatic feed will eliminate constant inkwell refilling and drying of the nibs. Designed along traditional lines, this ruling pen has an ink cartridge which holds the equivalent of 55,000 inches of ruled lines.

THE CHILD'S INTRODUCTION TO ARITHMETIC REASONING

H. VAN ENGEN
Iowa State Teachers College, Cedar Falls, Iowa

Probably no one subject in the field of arithmetic has received more attention than has the ever-present question of what to do about problem solving. Now it may or may not be true that the child who solves the traditional problem, as encountered in our arithmetic texts, reasons while solving the problem. However, it certainly must be true that those engaged in the study of this problem are desirous of shedding some light, directly or indirectly, on the reasoning processes of the child. If this were not true, too many of the research studies would simply degenerate into the study of arithmetic trivia.

Whatever has been the objective of researchers in arithmetic one is impressed by the fact that the literature on solving arithmetic problems indicates that the attention of those engaged in research has been too largely centered on the product of reasoning rather than the process of reasoning. There are obvious reasons for this state of affairs which need not be dwelt upon. There is much to support the thought that little progress can be made along the problem-solving line until some penetrating analytical studies have been made of the way children reason. The problem is difficult, as is frequently the case when we encounter crucial problems.

A very close analogy can be drawn between the present day status of the learning problem in arithmetic and the reasoning problem in arithmetic. Psychologists have found that much progress can be made by focusing their attention on the process of learning, rather than focusing their attention exclusively on the product of learning. As a result it is becoming increasingly evident that "how we teach" is at least as important, if not more important, than "what we teach." In problem-solving the studies are too frequently focused on the product rather than the process of problem-solving. It would seem that the problem-solving-learning analogy is so close that we should be able to say that "how we teach problem-solving" is more important than "what problems we teach." This is particularly true if teachers continue to analyze problems by the "step method" or on the basis of the occurance or non-occurance of a certain group of words.

It is interesting to speculate whether the interest in the product of the reasoning process has caused those interested in arithmetic to overlook a classical study in the field of psychology which contains much food for thought. It is surprising to find that Piaget's classical

study on "Judgment and Reasoning in the Child"[1], carrying a publication date of 1928 (as translated from the French), has been referred to so infrequently in the literature on arithmetic instruction. In fact, this author has found no recent methods book on arithmetic which includes this study in its references in spite of the fact that his study is vastly more important, as a potential determiner of method and content, than countless numbers of the studies referred to in the present day methods books on arithmetic.

In view of the fact that Piaget's study seems to be resting in an undeserved obscurity, it will be the purpose of this article to call attention to the fact that it contains much that is helpful to the arithmetic teacher if translated in terms of a meaning theory which has already been brought to the attention of the teachers of arithmetic.[2]

There is no need to review Piaget's study. A few quotations will make clear the trend of his thought, those who wish more details will be interested in examining the complete study, once more, just to refresh their memories.

In regard to the powers of introspection of the six to nine-year-old child Piaget says, "During the first stage (of introspection) or at least when he first attempts to handle a notion, the child either fumbles with his fingers, as when he tries to divide a pile of matches into two halves, or else applies automatically the ideas resulting from these manual operations. In both cases, reasoning consists of a succession of operations either manual or mental, but neither of them directed by a mental process that is entirely conscious."[3]

And again in much the same vein of thought, he says, "So that everything we have said in this work to show that the thought of the child is less conscious than ours has *ipso facto* led us to the conclusion that childish thought is devoid of logical necessity and genuine implication; it is nearer to action than ours, and consists, simply of mentally pictured manual operations, which, like the vagaries of movement, follow each other without any necessary connection. This will explain later on why childish reasoning is neither deductive nor inductive; it is consists in mental 'experiments' which are non-reversible, i.e. which are not entirely logical nor subject to the principle of contradiction."[4]

While these are the only two quotations from Piaget's study that will be given in this paper, the reader should not conclude that justice has been done to the importance of the study and all the im-

[1] Piaget, Jean, *Judgment and Reasoning in the Child*, (translated by Marjorie Warden) Harcourt, Brace and Company, New York, 1928.

[2] Van Engen, H., "An Analysis of Meaning in Arithmetic," *The Elementary School Journal*, Vol. XLIX Numbers 6 and 7, (February and March) 1949.

[3] *Op. cit.*, p. 142.

[4] *Op. cit.*, p. 145.

plications for the classroom teacher. However, enough has been quoted to form a basis for a discussion of the more important implications of the study for the teaching of arithmetic.

If the child's thought does consist of mentally pictured manual operations then it follows, by the simplest of logic, that his first experiences with number should be such that his attention is focused on the manual operations which represent an arithmetical idea. It is a mere psychological truism that only after having experienced these manual operations can a child eventually perform these manual operations mentally. In other words, to teach arithmetic reasoning, at the child's level, it is essential to have objects which the child manipulates under the direction of the teacher. These manipulations—these operations—these actions—will eventually become the basic elements of the child's thought processes when the objects are no longer present. At a more mature stage of thinking these basic elements are replaced by symbols.

In view of this basic thought pattern, the child's first experiences with a concept such as addition should consist of manipulating two groups of objects, in such a way that the two groups are first observed separately; then, the two groups are brought together and thought of as one group. For example; suppose the child is working with $5+3=8$. The child first observes the five objects then observes the three objects being brought toward the five group, with the final result that these two groups form a familar (to the child) pattern of eight. Previous experiences have made the symbol "5" and the symbol "3" meaningful. The experiences described above, and others like it, have made the symbol "+" meaningful (it becomes associated with those actions experienced while bringing together groups and thinking of them as one group). When taken altogether these simple manipulations have provided the foundation for the first stage in thinking, according to Piaget; namely, mental pictures of manual operations.

To add a group of 8 and a group of 5, the child should have a similar experience with objects with one important variation. There is the same association of the action involved when a group of 5 joins a group of 8 objects with the symbol "+". However, in this case the manual operation—the action—involved is somewhat more complex. The child must be taught that it has been found convenient to regroup these objects into a group of 10 and a group of 3. The regrouping must be manually performed to provide a basis for subsequent thought about 8 objects and 3 objects. Repeated experience will change the response from a thought process to an automatic reaction.

It is not necessary to go farther with our illustrations in order to impress upon the reader the importance of Piaget's study for indicating a new approach to teaching arithmetic meaningfully and may

we say "reasonably." After some consideration of the methods implied by this study, it is readily seen that too many of our arithmetic classrooms are as woefully lacking in those materials which are needed to teach arithmetic meaningfully and, even more important, to teach arithmetic in such a way that a proper foundation is provided for developing the reasoning processes of the child. Workbooks, arithmetic books, coloring pictures, writing numerals and dittoed sheets of "this and that" can be beside the point—no not beside the point but the tools which many develop psychological blocks which will prevent the child from reasoning quantitatively. Counting sticks, blocks, buckeyes, objects, objects and more objects are the instructional materials for the first experiences with number. Pictures illustrating arithmetic processes? Yes! Arithmetic books? Yes, but only after the concrete manipulatory experiences with objects. Drill on such complex grouping of symbols as $3+2=5$? Yes, but only after the teacher is sure that the child has had sufficient manipulatory experiences with objects that the child can dispense with the objects and mentally picture the operations—actions—when the symbol is presented in the absence of the objects. To teach children to reason about quantity; to teach arithmetic meaningly, the teacher does not need a shelf filled with workbooks. She needs boxes full of interesting objects to count; to form number patterns; to manipulate; to show what addition (the "+" sign) means, and to impress on the young minds in her charge what actions are represented by such symbols as "+".

Now what about problem-solving from this point of view? There is some reason to believe that future research will relegate such techniques as "cue words" and "read the problem carefully, 'then this', 'then that' " to the educational bone pile. These methods and others of similar caliber have never proven to be widely effective. Why? Because they are not even close to the heart of the instructional problem. Because they do not take into account the way children think. Childish thought is devoid of logical necessity. Watch how little children use the word "because." Used as a word indicating logical necessity it is a difficult word. Because childish thought is devoid of logical necessity an approach to the problem which seems "logical" to the adult will be merely another occasion for the child in which he does not see what it is all about. The method which requires the child to go through a series of steps, beginning with "Read the problem carefully" is too "adultishly" logical for the child. It has the additional advantage that it does not, in any way, aid the child to determine what must be done to solve the problem. It furnishes no approach to problem solving which is on his level of thinking.

Little more need be said about the "cue method" for teaching problem-solving. Developed in an era during which the stimulus-re-

sponse psychology held full away, it cannot teach the child to think. It can only produce automatons which may give wrong answers a high percentage of the time because the correspondence between the stimulus and the response is not a one-to-one correspondence.

What is the answer to the problem-solving dilemma? It would seem that Piaget has indicated a hopeful approach to this problem. In the early stages of thought a child thinks by visualizing the manual operations which have become associated with a given group of words. (Even adults do some of their thinking on this level.) Problem solving, for the child, then becomes the visualization of the actions (manual operations) suggested by the words used to convey the original quantitative situation together with the ensuing events. For example: Mary had six apples and she lost two of them. How many did she have left? Here the child, and the teacher as well if she is to interpret the situation for the child, visualizes six apples, or represents six applies by means of objects; then visualizes two of these apples disappearing (are lost). It is now evident by immediate observation that there are four applies left.

With many experiences of this kind the child eventually learns that any time a group is presented and then something happens to a part of that group, so as to leave the attention focused on the remaining group, such a situation is a subtraction situation. Furthermore, he eventually learns that such actions, and the events in such situations, are represented by the symbol "−". By this process the child learns to characterize a subtraction situation by means of its chief characteristic; that of separating a sub-group from the main group. The child learns that subtraction refers to those actions one encounters wɥɔu separating a sub-group from the main group.

The problem-solving activity has been illustrated by using only one of the subtraction situations frequently encountered in the early stages of arithmetic instruction. The method of characterizing other situations encountered in the early stages of arithmetic are so obvious that no time need be spent describing them. However, it is instructive to think through the actions suggested by these situations which are described, in their early stages, by the symbols "+", "−", "×," and "÷."

Summarizing the problem-solving discussion, it is possible to say that children learn to recognize what process to perform by visualizing what manual operations (actions) are indicated by the words in the problem. The generalizations involved are the same as those involved in making any other generalization. The child learns to ignore all elements of the experience except that one element which characterized the situation. To form a concept of the color green, the child must ignore the type of material on which the color appears; the

shape of the material; the extent of color patch; in fact everything except that sensation caused by light of a particular set of wave lengths which is commonly called green. In problem-solving the child must learn to ignore the kind of objects described in the problem; whether the action involved is described as eating, flying, disappearing, getting lost, and numerous other elements in the situation. However, he must learn to center his attention on those actions which define addition, subtraction, multiplication, or division in the elementary stages. This is the problem solving activity. This is thinking in its early stages. No other approach seems to offer as much hope for eventual progress in teaching children to solve problems. It is a fertile field for research.

INDIANA CONSERVATION EDUCATION CAMP

The 10th annual Indiana Conservation Education Camp for teachers will be held at Versailles State Park, Versailles, Indiana, June 13 to July 23, 1955.

The camp offers two consecutive field courses of three weeks each in the conservation of natural resources. The fundamentals of soil, water, forests and their conservation will be included during the first three weeks. The relation of animals to conservation, wildlife and fisheries management will be studied during the second three weeks. The interrelations of land use and human living and curriculum development in conservation education will be emphasized in both sessions.

Three semester-hours of upper division credit will be granted for completing the first three weeks of the course and six semester-hours for the full six weeks. The first three weeks is a requisite for the second part of the course.

The total cost of the course, including fees, meals, lodging and instruction, is $52.50 for three weeks or $105.00 for six weeks. Non-resident students are charged an additional fee of $17.50 for each three weeks session.

The camp is administered by Purdue University and is sponsored jointly by the Indiana Department of Conservation, the State Office of Public Instruction and Purdue. Further information may be obtained by writing to Howard H. Michaud, Department of Forestry, Purdue University, Lafayette, Indiana.

HARVARD SUMMER SCHOOL

2-N Weld Hall
Cambridge 38, Massachusetts

The Harvard Summer School and Graduate School of Education this year will continue their special program for secondary-school science teachers with three courses entitled, "Recent Developments in Physical Science"; and "Materials and Methods in the Teaching of Botany." A number of special fellowships are available for these courses, which will last from July 5 to August 17 and will each carry four units of graduate-level credit. The fellowships will cover tuition and registration fees, and some will also include allowances toward room and board or travel expenses.

In addition to these courses for secondary-school teachers, there will be a course on "Science in the Elementary School" for teachers and superivsors on the elementary level.

Teachers interested in applying for one of the fellowships may obtain an application blank from the Harvard Summer School, 2-N Weld Hall, Cambridge 38, Massachusetts.

TRAINING STOREROOM ASSISTANTS

ROBERT H. MITCHELL
Muskingum College, New Concord, Ohio

Many college chemistry departments use student storeroom assistants exclusively. It has been our experience, and no doubt the experience of other chemistry departments, that all too often the students lack both adequate training for and a professional attitude toward this assignment. It is highly desirable that storeroom assistants have a professional attitude toward their work. They should have sufficient training for the job to give them a real interest in and enthusiasm for it. Too frequently the student thinks of the financial remuneration as of primary importance, consequently he does the minimum amount of work to get by and requires constant supervision, Such an attitude is not conducive to good service and to the best possible departmental morale. Neither is it a good learning situation, and there is much good, practical chemistry to be learned in a chemistry storeroom if the student has the training to be aware of it. The pay should, however, be sufficient to attract the better students.

If the storeroom assistants are made to feel that they are an essential part of the chemistry departmental staff they are more likely to assume a professional attitude than if they are merely working to supplement their finances.

As a remedy for this situation why not offer a training course for storeroom assistants which would not only prepare them for efficient service in the storeroom but also make a valuable contribution to their chemical education, instill in them a professional attitude toward their work, develop in them a greater sense of responsibility, and be of use to them after graduation should they enter graduate school, industry or teaching? Herein is a suggested course of this type. While it may not, in this form, meet the needs of the reader it is hoped that it will challenge his thinking and imagination.

Such a course might be offered in one of several ways. It might be given as an honors course open only to that number of students needed each year to keep the store room properly staffed. These students should be selected on the basis of ability.

It might be offered as a one-semester course in Chemical Handling and Storeroom Management in which a considerable amount of time could be spent in laboatory work in storeroom activities.

It might be an "in service" type of activity. This would be a sort of apprenticeship with discussion periods at convenient intervals.

While the course need not carry regular college credit it should constitute a part of the student's academic record after he had completed one or more years of satisfactory service. Each year of storeroom

service should be included in the academic record and become part of all credit transcripts sent out by the registrar.

Early in the second semester new storeroom asistants might be recruited from the better first-year students who plan to continue in the study of chemistry. Selected students would be invited by the department head to take the training and should be made to feel that they are honored by being so chosen. Students who accept the invitation should agree to serve as storeroom assistants for not less than one year, although this agreement need not be binding. Continuation of service beyond the one year period should be contingent upon a good service record.

The course might consist of five major sections: 1) a general introduction to the storeroom, 2) safety and good housekeeping in the storeroom and laboratory, 3) laboratory first aid, 4) storeroom procedures and, 5) storeroom practice.

General Introduction

It would be the purpose of this section of the course to familiarize the prospective storeroom assistant with the methods of storing and handling chemicals and equipment, the inventory and check-out systems used, and to give him a general idea of the duties of a storeroom assistant. The work of the storeroom assistant should be outlined in more or less detail.

Safety and Good Housekeeping

Safety and good housekeeping go hand in hand. In the *Manual of Laboratory Safety* published by the Fisher Scientific Company, the following statement is made, "Good housekeeping becomes the most significant contribution toward an active safety campaign and can be achieved by prior planning and rigid adherence to the adopted plan." With this thought in mind good housekeeping and safety should be considered together.

Such topics as the proper methods of storing the various materials and equipment for ease of handling and safety, the proper type of container and closure for various types of chemicals, the proper means of protecting certain chemicals from light, heat, etc., should be discussed. Emphasis should be placed on proper labeling; no unlabeled chemicals should be stored, since unlabeled chemicals constitute a hazard and should be recognized as such. Consideration might be given to such topics as; what constitutes a complete label, what chemicals are toxic and dangerous, what chemicals may be given to the students without special authorization, how to handle dangerous and toxic chemicals safely, the use of gloves and goggles, proper disposal of chemical waste, etc.

Consideration should be given to the proper method of lifting heavy containers, and the proper and safe use of a ladder. The storeroom assistant should be familiar with the location and use of such safety and good housekeeping devices as the fire extinguisher, fire blanket, fire alarm, first aid kit, mop and broom.

Laboratory First Aid

The best first aid is the proverbial "ounce of prevention." The training in safety and good housekeeping is an effort to apply this prevention treatment. In spite of precautions, fires and accidents do occur. The store room assistant, therefore, should be instructed in methods of fighting small chemical fires and in the accepted methods of first aid for common laboratory accidents. Neither the storeroom assistant nor the faculty member can replace the fire department or the physician. In most cases, however, if proper means are used a small laboratory fire can be extinguished easily and quickly if action is prompt. Even if the fire is too large for the laboratory personnel to handle, when proper means are used it can be confined until the fire department arrives.

First aid, at best, is only a temporary measure until the services of a physician can be obtained and should be thought of always in these terms. Prompt first aid treatment is advantageous provided it is rendered by some one who knows what he is doing. The college physician might well take over this portion of the instruction.

A first aid chart containing the phone numbers of several physicians and the fire department should be prominently displayed in the storeroom. The local fire department might be interested in working with the group and discussing fire prevention and fire fighting. A knowledge of your layout and the type of materials you store would be valuable to your fire department in the event of a large fire.

Storeroom Procedure

The duties of the storeroom assistant should be considered in great detail and a list of duties and responsibilities given to the student. Attention should be called to his professional responsibilities and attitudes, such as reliability, promptness, student contacts, how and when to report off in case of illness etc.

The use of the inventory system will need explanation. It should be demonstrated that by the use of this system one may determine what materials are on hand, where they are located, how much is available and the source from which each item is obtained. The trainee should learn how to keep this record up to date and how to store and record all incoming materials. The use of the "materials needed" list should be explained and demonstrated.

Consideration may be given at this point to the whole topic of good housekeeping as it applies to the particular set up.

Storeroom Practice

This might be thought of as the laboratory portion of the course since it is here that the student gets actual practice in the storeroom. Trainees may be assigned to mix stock solutions using directions filed in the storeroom, to fill reagent bottles, to check out and in laboratory equipment etc. In short during this portion of the training the student should get practice in all phases of storeroom management.

All members of the chemistry staff including experienced storeroom assistants might cooperate in this training program. The college physician should be called upon to help with the safety and first aid instruction and if possible the local fire department should aid with the fire safety portion of the program.

SUMMER CONFERENCE FOR MATHEMATICS TEACHERS

The University of Wisconsin announces a Summer Conference for Mathematics Teachers to be held in Madison June 27 to July 22, 1955, in cooperation with the National Science Foundation.

Three Courses of lectures will be given:

1. Survey of the foundations of algebra, Professor Neal McCoy of Smith College, Northampton, Mass.
2. Introduction to statistics, Professor Henry B. Mann of the Ohio State University, Columbus, Ohio.
3. Studies in curriculum and instruction in mathematics. There will be four lecturers in this course, each lecturer taking the class for one week. They will be Professor Harold Fawcett of the Ohio State University, Professor Phillip S. Jones of the University of Michigan, Professor E. H. C. Hildebrandt of Northwestern University and Professor Henry W. Syer of Boston University.

Each of these classes will meet for 50 minutes daily, Monday through Friday, for four weeks. Upon the successful completion of these courses a member of the Conference may if he so desires receive three academic credits from the University of Wisconsin in either of the courses Mathematics 107 or Education 107 if he prefers.

One of the large dormitories on the shore of Lake Mendota will be set aside for members of the Conference and their families. Meals will be served in the refectory of the dormitory.

The National Science Foundation will offer stipends of $225 to each of 40 persons who attend the Conference. At least half of these stipends will be awarded to teachers in preparatory and high schools, but some of them may be given to college teachers who are interested in the preparation of high school teachers. Inquiries may be addressed to:

Professor C. C. MacDuffee, Director
302 North Hall
University of Wisconsin
Madison 6, Wisconsin

SCIENCE IN THE BEGINNING SCHOOL PROGRAM

MARY SAMTER
School of Education, University of Wisconsin, Madison, Wis.

The word *Science* on the written program of an elementary school room has become almost as common-place as the words language, arithmetic, or reading. A great deal has been written about the content and method of science and its place in the curriculum. Numerous texts on the market testify to its acceptance as well as interest. As with any other subject there are almost as may ways to teach it as there are children to be taught and teachers to teach. Yet, by its very nature it does seem to dictate certain general procedures and to set patterns for learning. For these reasons, along with others, it seems fitting that science should be a part of the beginning school program when habits are being formed, skills developed, and knowledge foundations laid.

My purpose is not to defend its place in the school program. That I accept because of the belief that every child who comes to school should expect that nothing fundamental shall be omitted from his education. Science is one of those fundamentals. I am interested in the research that has been carried on and grateful for the materials and methods available for my use. My job as a first grade teacher is a big one and is further magnified by a responsibility of training future teachers. I need all the help I can get.

The children I am meeting each fall are members of a very complex society. Some of them have traveled to the far corners of the earth by land, sea, and air. Others have been confined to the limits of the neighborhood but none of them knows a world without radio and perhaps without television. Curiosity and questioning are characteristic of children of any age and any culture. The greater the number of questions answered for them, the greater their curiosity and interest and hence, the increase in the number of questions. I must meet this interest with like interest, and attempt to help find some answers to satisfy this curiosity. I know that basic skills must be taught in readiness for reading, writing, and arithmetic. Unless the child acquires the tools he needs to meet success as he develops he will soon become discouraged and will lose much of his natural enthusiasm for learning. Being trained to look carefully and to observe accurately, helps in this skill developing program. Witness—one little line makes all the difference between "eat" and "cat." Ears must be trained to hear sounds for identification, for being told, for enjoying the world around us. The letters p-i-g put together say "pig." The word starts like "paper," "park," and "Paul." A picture gives an

idea of how a pig looks, but for some child a trip to see one may reveal that it is not a flat, pink, two legged animal. First hand experiences cannot be omitted. Being able to touch as well as to look and listen provides another avenue to learning.

Children enjoy drawing pictures of interesting things they have seen and done. Practice in the use of crayons, paint brushes, pencils, and chalk assist the child in acquiring muscular coordination involved in the skill of writing. Drawing pictures as the result of observations serves this purpose as well as serving as a check on comprehension and memory. Although it is not always necessary to have a reason for practicing skills other than perfecting the skill itself, it is necessary to use many and varied approaches in teaching children to observe, to think, to gain and apply information. The teaching of science seems to provide a natural approach in this program. Its subject matter, the Universe, the World around us, and Ourselves, make up all those things children want to know. In working together to find answers there must be cooperation and consideration for others. To illustrate:

One morning Jean came into the room followed by a mob of kids eager to got a look at some mysterious thing she had hidden in a box that she was carrying very carefully. Children gathered around to prepare for the showing. As she removed the cover of the box out crawled a big furry caterpillar. Immediately someone wanted to know, "Where did you get it?" "What was it doing?" Jean could answer those question, but the next one, "What kind of a caterpillar is it?" brought challenge and disagreement. The teacher entered in with the idea that ouside help might be needed. How could they find out just what this was? Several ways were mentioned:

"I'll ask my father."
"There are some pictures in a book."
"Mr. Smith would know."

Jean wanted to keep the caterpillar at school so there were some other questions to be answered and problems to solve. The teacher, with the pattern and procedure all set, capitalized on the natural motivation and put her preconceived plans into action. (What fall doesn't bring forth a wealth of such specimens and what child can't be led to an interest in the things he sees about him?)

If the caterpillar were going to stay, there were other things that would have to be known. After some little argument it was decided that no one actually knew what caterpillars eat, where they live, and what they do in the winter time. The questions (or problems) were dictated by the children and written on the board by the teacher.

1. What kind of a caterpillar is it?
2. What does it eat?

3. Where does it live?
4. What does it do in the winter?

To find the answers some of the children were chosen to go to the science department to describe the caterpillar and to ask Mr. Smith for help in identification. Some went to the library and others stayed with the teacher to look at books in the classroom. In the meantime the caterpillar safely awaited its fate in a glass jar.

The following day they were ready for reports. The questions were read with the help of the teacher. Answers were given and discussed. Since "woolly bear" caterpillars hibernate, and this was a "woolly bear" caterpillar, it was decided to make a home in an old acquarium tank, set it out and watch to see what would happen. The whole class went out to get the sand, stones, grass, leaves, and twigs. All had a chance to assist in making the home and when the job was finished each one drew a picture illustrating some part of the activity.

All pictures were put into a book with the story:

Jean brought a woolly bear caterpillar to school.
It eats leaves and grass.
It hibernates in the wintertime.
In the spring it will turn into a moth.
The moth will be an orange brown color.

The book was placed on the library table to be read, discussed, and enjoyed.

By this time there was not only a caterpillar in the room, but a shelf full of jars holding interesting looking things that crawled around. With the background just acquired the children were ready for more information and a pattern for "finding out" had been set.

A name for these specimens brought the word "insect" into their vocabularies. Looking at a grasshopper with a hand lens revealed the fact that there were three parts to its body and that it had six legs. Information gathered this time was summarized in the form of an outline.

Do you know insects when you see them?
All insects have six legs.
All insects have feelers or antenna.
All insects have 3 parts of their bodies.
1. head
2. thorax
3. abdomen

No attempt was made to keep a written record of all that was learned. Most children were interested enough to listen attentively to such things as:

Why caterpillars eat so much.
Which ones become moths and which butterflies.
That grasshoppers and crickets develop from eggs.
That some insects are harmful and some helpful.

Continued attention was given to this study through incidental remarks, first hand experiences, and the review of stories. In addition to any learning which may have taken place, it was fun—for both the teacher and the children.

But interest and curiosity are never confined to one area. Everyone who works with children is familiar with the questions:

What makes it go?
How does it work?

Though it is sometimes thought that boys have greater interest in ideas relating to physical science girls have demonstrated equal enthusiasm, particularly when applied to things about the home. A study of machines started with a very commonplace discussion—one that might be heard in any primary school room (though I should add that this did not happen incidentally—careful plans had been laid).

Pictures relating to family life were being shown and captions read:

Sometimes we work.
Sometimes we play.
Work can be fun.
Play can be fun.

As pictures showing the family at work were used and childen discussed the work they did at home the teacher asked the question, "Did you have any help with the work you did this morning?" After answers were given, attention was directed to the bulletin board where such things as brooms, hammers, forks, spoons, etc., were displayed. The next questions were, "Did any of these things help you?" "How?" "What are these things called?" Children were led to make the statements:

"Tools help us work."
"Tools make work easier."

They were told to look about them at home and to name some things they use to make work easier. The next day the discussion continued and a list was made as the children named the tools they used. It included the following:

spoon	pliers
fork	pencil

plow	brush
comb	dishwasher

An objection was raised to the dishwasher, for that was a machine. After allowing discussion the teacher asked, "What is a machine?" "Are forks and pliers machines?" That brought a laugh. How ridiculous! The teacher remarked that there were little machines and big machines. A good discussion about simple and complex machines was found in *Tell Me* by Ellen Wales Walpole which told convincingly that pliers and dishwashers are both machines. The lesson was concluded with the summary:

Machines help us do work.
We have to work with machines, they cannot work alone.
There are big machines and little machines.
Machines help us to:
push, pull, lift, fly

It was suggested that children bring some toys from home to show the class how machines work. Toys brought ranged all the way from a toy hammer to electric motors and a toy sewing machine. The child who brought the machine demonstrated and told about his toy. When he was through the class asked questions. During this time the teacher purposely used the words, "lever, pulley, screw, wheel, inclined plane, and wedge." Frequently a child used these words in his demonstration. Some of the questions that grew out of this lesson were:

1. How does the motor help us work?
2. What makes one wheel turn another?
3. Why are there bumps on some wheels?
4. How does a pulley work?
5. Do you have to have something at both ends of a pulley?
6. Is there another name for an inclined plane?
7. What is a lever?
8. What kind of a machine is a hammer?

These questions were used as a starting place for the study of simple machines. The fact that all answers couldn't be found at once made it necessary to regroup the questions, or using Chuckie's words, "We should get things bunched together that are about the same things." That was done and the teacher told them she had prepared a lesson for that day telling about levers. The following story was told using Ching as a character with whom they were familiar through a simple number story based on the history of arithmetic.

Do you think Ching had machines to help him work?

"One day Ching's father had nothing to do. He had enough food for the family to last for awhile. Ching was watching the sheep, mother was working around the hut. Father sat and rested and thought about many things. Mother asked him if he thought he could get a big stone for her that was outside the hut. She thought if she had that stone and could get it warm near the fire that it would hold the heat and help to keep things warm. Father said he would try to get it. He took a stick and dug around it. He pushed and pulled but he could not get it. He got so tired that he sat down to rest. While he was sitting he poked around with his stick and accidently flipped a little stone. It lifted very easily. Father sat up quickly. He had an idea. If he could lift the little stone with the little stick—why couldn't he lift the big stone with a big stick. He tried it and it worked. He got the big stone for Mother. He told others about how the long stick helped to lift. Soon he was using his new idea to help him lift lots of things. It could lift heavy things that he couldn't lift by himself. He found out too, that the longer the stick—the easier it was to lift things. Let's see if we agree with Ching's father.

Experiment:

A cord was tied around a heavy box and children were asked to lift the box to find out that it was heavy. One end of a yard stick was placed under the box and children tried lifting it again by using the stick. Then a block of wood was placed under the yard stick and again the box was lifted. It was learned that the heavy box could be lifted easily by using the yard stick and the block of wood. The closer the block was to the heavy box, the easier it was to lift. Thus the words "lever" and "fulcrum" came into use.

The next day a work sheet was given:

What is a lever?
(space)
What does a lever do?
(space)
Draw a picture.
(space)

Each one of the simple machines was studied. Sometimes the lesson was motivated by solving a practical problem within the classroom such as:

1. Watching the janitor repair a broken window shade that operated by the use of a pulley.
2. Using a hammer to put up a thermometer.
3. Finding a wedge to use as a door stop.
4. Taking a wagon load of toys up a sloping hill.

Science books written for the use of the teacher describe many experiments suitable for use in working with young children. Some of the pictures so clearly illustrated experiments that the children could set them up themselves. They shared this responsibility with the teacher. One day Glen brought in a pulley he had made at home using a spool, a nail, a board, and some string.

At all times children were led to observe, to think, to try to find answers, and to apply information. Each time a simple machine was identified it was related to machines they knew. Many times it was possible to find all the simple machines combined to make one big one, e.g. a dump truck.

Summaries took different forms:

1. Factual stories read from Science books.
2. Fanciful stories just for fun.
3. Oral reports to other groups.
4. Pictures—drawn by the children and collected from magazines.
5. A scrap book telling a story, e.g.

The Story of Wheels

Page 1. LONG AGO PEOPLE DIDN'T KNOW ABOUT WHEELS.
THEY HAD TO PUSH AND PULL HEAVY LOADS.
(space for child to draw a picture)

Page 2. THEN THEY BEGAN TO USE ROLLERS.
LOGS WERE THEIR ROLLERS.
(space for child to draw a picture)

Page 3. THEN THEY SLICED THE LOGS AND MADE WHEELS
THEY MADE A HOLE IN THE CENTER OF THE WHEEL
(space for child to draw a picture)

Page 4. A STICK WAS PUT THROUGH THE HOLE IN THE WHEEL. WE CALL THAT THE AXLE.
(space for child to draw a picture)

Page 5. WHEELS ARE IMPORTANT MACHINES.
(space for child to draw a picture)

The methods that have been described in these two areas of study are far from exhaustive. Ways of presenting the subject matter of Science seem almost limitless as children, through their interest and absorption bring in new ideas, pose new problems, or reveal hidden

needs. To the teacher who must meet children's needs, help to develop skills, and teach the fundamentals, there is satisfaction and challenge. Science belongs in the beginning school program.

DEMONSTRATIONS FOR TEACHING THE PROPERTIES OF COMBUSTIBLE FLUIDS

ROBERT H. LONG
Green Mountain Junior College, Poultney, Vt.

Nancy was not her real name, but the accident was authentic; it happened suddenly on a Sunday morning; a flash, screams and then the life of a happy high-school girl was snuffed out. The tragedy came about as a result of a simple combination of chemical and physical principles that, like most other people, Nancy did not known about.

Nancy, still in her filmy pajamas and lounging coat, filled her empty cigarette lighter, accidently splashed some of the fluid down over her clothes, and then, without a thought, flipped on the lighter. And then it happened—her clothing was afire.

Why did this accident happen? Let us trace the action. First, the fluid spread rapidly over the fine cloth by capillarity, thus forming great surface area for rapid evaporation of an already very volatile liquid. So the girl was almost immediately sheathed in a layer of combustible vapor. The flame of the lighter did the rest.

The point that this incident suggests is that with the increasingly wide-spread use of combustible fluids—both gases and liquids—more attention should be given to the teaching of the practical chemistry of such substances. The basic chemical and attendant physical properties of this class of substances should be given special emphasis in beginning chemistry courses. The reason for including the material is simple: The principles involved are among the most common that most people will, in every-day life and the laboratory, meet up with. As the old saying goes, "First things should be first."

The following information and demonstrations are offered as a means of filling, at least in part, this noticeable gap in the study of the properties of oxygen. The demonstrations quickly capture the interest of students, and, therefore, have a high degree of learning value. However, they must be done with extreme care and only after practicing. If performed for high-school students, the appointing of several emergency "firemen," armed with extinguishers, will help emphasize the inherent dangers.

POURING FUEL GAS

The striking and very important property of common fuel gases

(bottled gas, etc.) that they will flow and can be poured is shown by the following demonstration: By means of a section of rubber tubing connected to the gas outlet, fill a 2000-ml (or large) wide-mouthed bottle with the gas, just as one would fill it with water. (Caution: this will take only about one second.) Interest will be aroused at once because students always associate the act of pouring with a visible liquid.

With a cover-glass over the mouth of the bottle, carry it to the other end of the demonstration table and then carefully pour the contents into a large beaker of about the same size (Figure 1). To prove that gas has been poured, quickly ignite it at the surface. A pre-test may be done on the beaker with a lighted match to show that the beaker had nothing but air in it at the start.

Now the class will be ready do discuss the possible places were similar circumstances might come about. For example: (1) Down the sides of laboratory tables. (2) In the cellars of homes, if gas should leak.

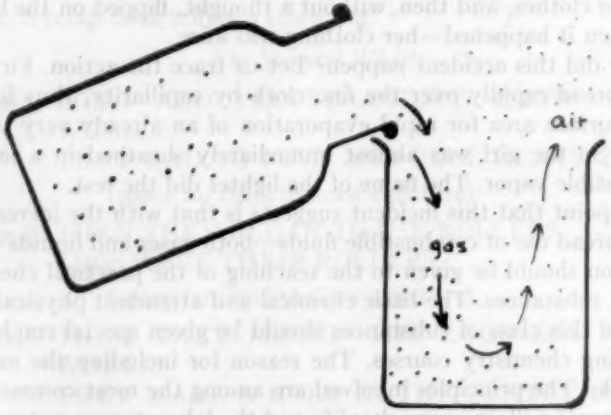


FIG. 1. Demonstration: flow of fuel gas.

FLASH POINTS

The following demonstrations can be used to explain some of the important properties of combustible vapors that come from volatile liquids, so commonly used—including thinners, lighter fluids, cleaners and some antifreezes.

Some combustible liquids give off enough vapor at room temperature that such fumes will flash in the presence of a flame. This principle can be demonstrated by filling (almost to the top) separate test-tubes containing rubbing compound (ethyl or isopropyl alcohol), shellac thinner (often mostly wood alcohol), lighter fluid, and finger-

nail polish remover (often acetone), and benzene. Test each with a match flame to determine if they ignite. A like portion of motor oil can be tested to show that not all cumbustible liquids give off enough vapor at room temperature to be ignited easily.

To show that some liquids will not flash until heated, a few grams of vegetable oil or cooking fat can be heated in a small beaker until appearance indicates that it is very hot, then ignite the vapors. A control test may be done before heating.

These demonstrations are good object lessons in handling volatile liquids, especially rubbing compounds, lighter fluids and using cooking fats over open flames.

Dangerous Fumes from the Very Volatile Liquids

Closely associated with this group of substances are the extremely volatile liquids with the attendant danger zones. This group includes

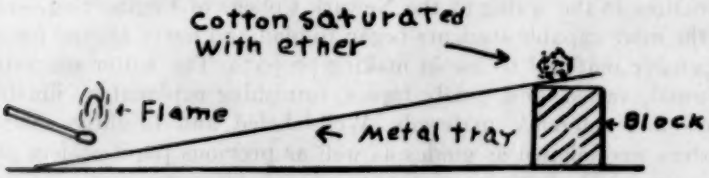


Fig. 2. Demonstration: danger zone near very combustible liquid.

ether, gasoline, some cleaners; and lighter fluids might also be included here. The principle to emphasize is that these substances give off such copius volumes of vapors that the "distance factor" becomes very important. As many persons have observed, if gasoline is used to kindle, say, an outdoor rubbish fire, the participant often learns, surprisingly (and sometimes fatally), that when he strikes a match at a seemly safe distance he is suddenly confronted wlth violent combustion.

This can be demonstrated by placing a small ball of cotton (about the size of a marble) saturated with ether on an inclined tray (Figure 2) and, after a few seconds, bringing a lighted match slowly up the surface. When the flame reaches the mass of vapor flowing down the tray, it will strike up the plane to the cotton.

This principle can then be related to danger zones around gasoline pumps, cleaners on cloth and when such liquids are spilled.

Water-resistant paints for interior walls have been tested to show their ability to stand up for added years against acids and alkalis. Available in a wide-range of color, they are based on a vinyl acetate resin latex.

A PROJECT FOR OUR TIMES

AN ATOMIC POWER PLANT

MAITLAND P. SIMMONS*
Irvington High School, Irvington 11, New Jersey

In recent months widespread interest has been shown by the daily press and periodicals in the use of projects as a teaching aid for secondary teachers of science. It is generally agreed that through worthy achievements from this kind of learning, youth has an opportunity to develop attitudes that help to prepare him for life as an everyday citizen.

Students are more likely to build projects and spend long hours on them if they know they will be exhibited publicly. With the announcement that there was to be a Greater Newark Science Fair sometime in the spring at the Newark College of Engineering, some of the more capable students began to plan and hurry around for inexpensive material to use in making projects. The writer suggested unusual, varied, and timely topics, furnishing explanatory illustrations and reference materials. Well-labeled and brightly colored posters were shown as guides as well as previous pupil-project pictures, particularly those relating to our school.

To follow up the true progress of the student's work and to offer pertinent suggestions, required out-of-class time on the part of the instructor, including visits to the home. However, these friendly periodic conferences afforded an excellent opportunity to become acquainted with their parents.

The illustration is a pictorial example with a brief description of one of the exhibitor's constructions, an immobile scale model of a peacetime power plant as to how it would look in the near future.

Using a picture of an atomic plant in *Life* magazine as a guide, the initial step was to calculate the magnitude of the various structures keeping the over-all pattern within a three by four foot plywood base. Next came the actual construction of the units. For the reactor, a nuclear-fueled chamber covered by a concrete shield, a cut-away section of hollowed balsa wood was made to simulate the concrete. The shell was partially filled with papier-mache. While the paper was still wet, a croquet ball was embedded in it to represent the reactor. From this, cooled and heated fuel pipes made of wood were attached to the heat exchangers.

To build the two cut-away heat exchangers or boilers, stove pipes were used. Birch dowels were supplied for the inside fuel tubes of the

* Mr. Simmons is chairman of publicity for the Greater Newark Science Fair and President of the New Jersey Science Teachers' Association.

boiler. Much difficulty was experienced as fifty of these pipes had to be fitted into position.

The turboelectric generator was cut to shape out of solid pieces of balsa wood. This was placed between the heat exchangers.

Hours of patience and painstaking effort were needed to erect the single tension tower as numerous tiny pieces of balsa wood had to be cut, fitted, and glued together. This was connected to the generator by heavy black thread to represent electrical wire.

Other buildings included a group of chemical processing plants, a hospital, and heating units.

Richard Kopp of Irvington High School points to his immobile scale model of an atomic plant at the Greater Newark Science Fair.

Next came the painting of the various pieces. A flat white paint was used followed by multi-colored enamel gloss which gave them a shiny appearance. The parts were then glued firmly in their proper places to the plywood base which had been previously painted green and sprinkled with artificial grass to give it a realistic and colorful effect.

The final step was to design an attractive poster. It described the workings of the entire plant in outline form. The title *Peacetime Use of Atomic Energy* was used.

After displaying the project at the Greater Newark Science Fair

and at our high school, the writer suggested to the boy that he describe his out-of-school activity by means of a 300-word report. The paper was entered in a nation-wide contest conducted by the Future Scientists of America Foundation. For this outstanding piece of work, a certificate of Meritorious Achievement was presented to the boy. This presentation was made by a member of the American Society for Metals at one of our school assemblies.

It is impossible to know when a scientific project will begin to bear fruit or in what manner it will become productive. However, we can be sure that the results of experimental research in the secondary area will not fail to insure a product which shall never be considered a surplus commodity by the pupil or the teacher.

NEW KEYSTONE OVERHEAD PROJECTOR, NO. 1055

A new classroom teaching lantern-slide projector that is more compact, has brighter illumination on the screen, is quieter, also cooler—it has a double-walle lamphouse and a more effective newly designed cooling system. It will take projection lamps of 500-watts, 750-watts, 1000-watts.

The new Keystone Overhead Projector No. 1055 offers the same widely varied usefulness and flexibility as the original Keystone Overhead—it projects standard ($3\frac{1}{4}'' \times 4''$) lantern slides; multiple Tachistoslides ($4'' \times 7''$); and with accessories also projects two-inch slides, strip-film, and microscopic slides.

It is easily carried around with or without a case. The outside measurements of the case are—18″ high, 17″ long, 8″ wide. Keystone View Company, Meadville, Penna.

A WORKSHOP ON THE USE OF RADIOISOTOPES

A two-week Workshop on the Use of Radioisotopes in High School Science Teaching will be held at Iowa State Teachers College, Cedar Falls, Iowa, June 13–25, 1955. It will be conducted under the direction of the Science Department of the College with the technical assistance of the Atomic Energy Commission. The local staff will be augmented for lectures by visiting scientists who are authorities in their field.

This is a pioneering attempt to meet the needs of high school teachers and teachers of beginning college science courses by providing them first-hand acquaintance with radioisotopes. The workshop is planned with the idea that the use of radioisotopes for this purpose is both practical and safe. Lectures, audio-visual aids, and individual study will be used to present the subject. Participants will obtain direct experience with instruments and radioisotopes by laboratory work each day. Considerable attention will be given to developing experiments suitable for use by each teacher in his or her teaching position.

Enrollment in the Workshop is restricted to twenty-four participants in order to provide proper laboratory experience for each.

A grant from tne Standard Oil Foundation, Inc. has made possible the offering of twenty scholarships.

Married teachers are invited to bring their wives. Housing for both will be provided for a limited number in one of the men's dormitories.

Address your inquiries to J. W. Kercheval, Science Department, Iowa State Teachers College, Cedar Falls, Iowa.

DEVELOPING CONFIDENT, SELF-RELIANT LEARNERS IN ARITHMETIC*

ELINOR B. FLAGG
Illinois State Normal University, Normal, Illinois

Huckleberry Finn, that ever-alive character of Mark Twain's, is made to say, "I could say the multiplication table up to six times seven is thirty-five, and I don't reckon I could ever get any further than that if I was to live forever. I don't take no stock in mathematics anyway."

Troubled little "Understood Betsy," a character created by Dorothy Canfield, came to her arithmetic class "very low in her mind. She hated arithmetic with all her might, and she really didn't understand a thing about it! By long experience she had learned to read her teachers' faces accurately, and she guessed by their expression whether the answer she gave was the right one. And that was the only way she could tell."

Robert Lawson, illustrator of *Ferdinand*, and author of *Rabbit Hill*, in his biography—*At That Time*—speaks of his difficulties with long division: "Now I simply couldn't do long division. I hadn't grasped the underlying principles and didn't know how to proceed. At my desk, given peace and time, I could manage to stumble through a fairly simple problem. But at the blackboard, with my ineptitude spread out for all the world to jeer at, what little brain I had oozed out like the sweat that began to trickle down my neck."

"On either side I could hear the chalk of the others rattling efficiently against the slate as they raced through their problems—nasty, smug, little smart alecs! Each, as he finished, wheeled smartly around and stood expectantly at attention, while I, barely begun, continued to writhe and sweat, trying wilder and wilder methods.

"Eighteen into thirty-six—eighteen into thirty-six. Desperately I would try five. Too confused now even to multiply, I would get something around ninety. Much too much. I tried three times—still too much. How about once. That seemed better. Now, eighteen from thirty-six, what's eighteen from thirty-six? Eight from six is what? Eight from six—eight from six—borrow one from three, that's sixteen—eight from sixteen—eight from sixteen! Wildly now I count on my fingers—nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen. Eight fingers, that's eight. Now one from three; no, one from two—one from two's one—eighteen!

* Read before the Elementary Mathematics Section of the Central Association of Science and Mathematics Teachers at Chicago, November 26, 1954.

"That can't be right, but eighteen goes into eighteen once—that's another one for my answer—makes eleven—doesn't seem right—I'll have to prove it. Eleven times eighteen—eleven times eighteen—one times eighteen's eighteen—one times eighteen's eighteen, moved one over. Eight plus ought's eight—eight plus one's nine—one plus ought's one. One ninety-eight. All wrong! Rub it out and start over!

"The chalk is damp from my hands and writes greasily—the smell of the dusty felt eraser is choking—there goes a train, I wish I were on the train going home— wish I were on the tracks under the train—I wish I was that fly buzzing against the window—someone titters—my blouse string is untied—my stocking is falling down—my clothes are soaking wet. Miss Barrows is going over our results now, commending, correcting—she is only three from me and I'm not even started —eighteen into thirty-six, eighteen into thirty-six, and that's only the beginning—the whole problem is eighteen thousand nine hundred and forty into thirty-six thousand four hundred and fifty-two—why doesn't the bell ring? Why isn't there a fire drill? There's another giggle—It was all too much." P. 32–33

The English poet dramatist, John Drinkwater, has put his mathematical dilemma into a poem called *Multiplication:*

"Multiplication is vexation,"
That is a thing they said,
And from twice times then to ten times ten
It bothers me in my head.

I can do quite well if I'm told to tell
The whole of a Table through,
But dodging about quite puts me out
Till I don't know what to do.

When seven times five are thirty-five
I can tell you seven times six,
But seven times eight must kindly wait,
Or get me into a mix.

And yes, if you please, in the middle of threes
They asked me eleven elevens,
And that is the kind that makes my mind
All at sixes and sevens.

Now—to a few of to-day's children:

Dick, a second grader, showed his mother a list of numbers he had written—a list from 1 through 9; he informed her that placing a 1 "over here" (he indicated the left side of the written symbols) would add ten to each number.

Billie, a third grade child who knew how to add two 2-digit numbers

without carrying but had not yet learned the skill of carrying, showed this illustration to his teacher:

$$\begin{array}{r} 37 \\ 19 \\ \hline 16 \\ 4 \\ \hline 56 \end{array}$$

He proudly explained that he knew he was right because he knew that 37 and 20 made 57; 19, he said, is 1 less than 20, and so 39 plus 19 would be one less than 57.

Douglass, who was in the fourth grade, was asked what the fraction 3/5 meant. Doug hesitated—they hadn't had any like that yet, he said—but, he added, wait a minute. On paper he wrote $\frac{1}{2}$ and $\frac{1}{4}$, then the questioner wrote 3/5 on the same paper. Doug still hesitated but shortly he looked up and said—You have a circle in five parts—all alike. The patient listener said Yes, and then Douglass continued, "That (pointing to 3/5) might mean that only three of them showed."

Patty's father, wishing to try out his daughter's arithmetic ability, asked her how much three four's made all together. (Second grade) Patty, who was playing in the yard, asked, like Douglass, to be given a little time. She picked up some small sticks from the ground, laid out four with ease, then four more, and then another group of four. Aloud she said, "Four, eight, nine, ten, eleven, twelve. Dad, it's twelve; see?"

Stephen's mother was fixing Easter baskets; she recalled that she had heard Stephen (first grade) say that he didn't think he could ever do the divide problems his older sister, Audrey, had said were quite hard. Stephen was called to help with the baskets. "These eggs go into these baskets," his mother said, and she pointed to three baskets; "I want the same number of eggs in each basket, and I thought you might help me." Stephen counted the eggs—there were twelve. "How many in each basket, mother?" "Well, you might start by putting one in each basket—" He did so, and without further prodding, he continued the motion. Dubiously, he looked into each basket—"Four in each" —he called to his mother. "You've been dividing, Stephen." "Is that all Audrey has been doing? That's neat."

The people cited in the references to literature were bewildered; perhaps they reflect the kind of teaching through which many of today's adults got their introduction to arithmetic. The children of to-

day apparently have the beginning of a comprehension of the system called arithmetic: Dick, without putting the laws into words, knew that the number appearing at the left of another number was of greater value than the digit on the right; Billie knew that ones and tens had to be kept in their proper places and that only like numbers can be added. Douglass showed a resourcefulness in extending what he knew about $\frac{1}{2}$ and $\frac{1}{4}$ to a fraction other than a unit fraction. Patty showed a recognition of groups of four, and apparently knew the meaning of the expression three four's; she was able to do "partial counting"; all this, even though she had not yet accomplished an automatic response to her father's question. Stephen, at least for the moment, was free of a frustration concerning division.

The title of this paper indicates two desirable characteristics of any learner: confidence, and self-reliance. Self-reliance suggests the ability to re-discover, to re-build, out of past experiences (or associations) a once-almost-known-and-now-almost-forgotten idea, or fact. It suggests that the learner will be able to "write his own ticket" to success in arithmetic.

If the learner has the capacity to re-build associations, probably he may also develop some ability for making new associations; also, he may, if he is self-reliant, discover for himself, a variety of ways for reaching conclusions. The child who has been guided into making discoveries will be a continuous learner; he may be able to extend his present learnings into new fields. The self-reliant child will have the capacity for "growth in arithmetic"—to use an expression from John R. Clark.

How can teachers help children to grow arithmetically with confidence and self-reliance? Research indicates that teaching for understanding is an important part of the answer. If the teacher is to teach for understanding, if he is to give meaning to the arithmetic he teaches, he must (1) have the desired understandings himself, and (2) have the ability to help children accomplish these understandings.

It is suggested, first, that the teacher have an appreciation, an awareness, that arithmetic is based on accepted definitions and laws. He must be aware that arithmetic has as its foundation, words and symbols, whose meanings have been determined in an arbitrary way. True, arithmetic is a discipline in which reasoning plays a large part, but reasoning is possible only after definitions of terms have been agreed upon, and laws for operation of these definitions have been accepted.

The teacher must be aware that, therefore, the early learnings in arithmetic are memorized learnings. The name given to a particular group, and the laws for combining symbols, have been arbitrarily agreed upon. To illustrate: the name given to a group of *four* is an

arbitrarily chosen term; the fact that *five* means one more than four is an arbitrarily assigned idea; the laws that say "ten of one order make one of the next higher order," and that "higher orders are placed at the left of the lower orders" are arbitrary. The appearance of symbols is another fact that must be accepted. Definitions of certain words such as perimeter, area, fraction, divide, add, square, and scores of others—these definitions must be accepted by teacher and by learner—if the present system of numbers, and arithmetic as it is conventionally used—are to be taught. They must be accepted by any learner who is to be successful in arithmetic.

The fact that many of the arbitrary learnings (memorizations) come in the early stages of number experience leads many otherwise intelligent people to assume that all arithmetical learnings are memorizations: it may easily give children the notion that everything in the subject called arithmetic is a something to be memorized.

Teachers, in developing understanding need to distinguish between those learnings which are arbitrary and those which are the logical outcome of the system. Reasoning cannot be applied to the early learnings in arithmetic. The task there is one of providing so many associations for the terms to be learned that memorization is letter-perfect—or rather, number-perfect. To be sure, it is possible to have the definitions of terms memorized before experience is provided for use of the term, but these terms will have more meaning—they will be a more vital part of the learner's life—if concrete experiences are used—are built upon—before the terms are introduced.

Ralph Waldo Emerson has something to say which is appropriate here; in his essay on Self-Reliance he says, "It seems to be a rule of wisdom not to depend on memory alone, even in acts of pure memory, but to bring the past for judgment into the present." Emerson was not an authority on the teaching of arithmetic, but in this quotation he has the nucleus of a present day idea concerning associations which will assist a learner in recalling an idea, a term, a fact. To-day, his statement might be given this interpretation: guide the learner in such a way that he will find it possible to build up so many associations that he will not fail to make the proper recall—that he cannot fail to make the conventional association.

Books concerning the teaching of arithmetic are filled with advice to teachers on this point. But concrete experiences cannot be put into a text, or into a work-book; picture associations, semi-concrete experiences, and associations with the abstract number idea can be learned from books. Materials appropriate for use in giving concrete number experiences are available in great variety, but perhaps the children themselves are the most effective teaching aid: they may form groups to represent concretely the meaning of numbers; later

they may group and re-group themselves to show the meanings of operations.

It may be wise to mention that use of concrete materials can be overdone—they can be used to excess. These experiences will be overused if the teacher insists that the concrete materials be used after the child's number concepts have matured to the place where he no longer needs them to help recall a term—to make any association. To insist upon use of concrete materials after meaning has reached the abstract stage is to use them beyond the point of best returns; R. L. Morton says that it may result in "failure to develop in pupils the ability to do quantitative thinking in the abstract."

The self-reliant learner will have to acquire a meaningful vocabulary of arithmetic terms; he will have to memorize the appearance of the symbols used in arithmetic and be able to reproduce them; he will have to learn conventional ways for combining these symbols. All these are memorized learnings; discovery plays no part in them.

The development of these elementary learnings takes time, but it pays good dividends. It requires more ingenuity on the part of the teacher, and more time on the part of the learner—more growing time—more maturing time—than teaching for memorized learnings alone. History shows that the arithmetic heritage of to-day's child grew slowly; the symbols, laws, and vocabulary were in process of growth thruout centuries. In a few short years it is required of children that they reach a stage of maturity which was accomplished by the human race only after centuries of development. Authorities seem to agree that there is a need to remain for a longer period of time in the concrete and the semi-concrete stages of number development, and to make a more gradual transition from concrete situations to abstract. Too often in lower grades, this transition is abrupt and children are left with inadequate understanding of the relation of the abstract number to the concrete. When number names, their sequence, and their meanings have been learned, then, and only then, the learner is ready for reasoning. With this foundation, discovery can play a major part in making the learner self-reliant. It is impossible for children to discover that this group *** has the name *three*, or that this group **** has the name *four*, but once these names have been made meaningful, the idea that 3 and 1 make 4 is almost a discovery to the child. And if other number meanings are clear to him, he is all set to discover that 3 and 2 make 5, that 2 two's make 4, and 2 two's make 6—and so on; the entire world of number relationships is open to him. In the 50th Yearbook of the Society for the Study of Education, Esther Swenson makes this statement: "methods which lead the children to discover relationships and note generalizations yield superior learning results."

Now a second suggestion for the teacher: he should be aware that arithmetic is a system; it is a logical system in which certain ideas grow out of previously learned ideas—a system in which certain learnings are dependent on other learnings. It is a system in which teaching sequences are important,—that is, the understanding of certain phases is essential before certain other topics can be introduced understandingly. Years ago—1921, E. L. Thorndike in *New Methods in Arithmetic*, p. 58–59, made the following statement: "Arithmetic consists not of isolated, unrelated facts, but of parts of a total system, each part of which may help to knowledge of other parts if it is properly learned."

To be more specific about the sequential development of arithmetic, let us examine the following order of events: out of the meaning that has been given to number, and to groups, the idea of rational counting grows. From the acceptance of rational counting, the idea of addition can be made meaningful, and useful, for addition is but a shortened way to do counting. And once counting and addition are understood, subtraction, multiplication, and division can be developed—not mechanically—but with meaning attached to the words. Unit fractions can be given meaning by associating them with division; the meaning of other fractions can be developed from the meaning of a unit fraction. A decimal is merely a special fraction written in a new way (the sound of the word is the same as if it were written as a common fraction), and a per cent is a special decimal, written—again—in a new way. (The idea of a decimal fraction can also be made meaningful as an extension of our decimal system of numbers—using negative exponents—this is scarcely on the level of the elementary children, but the teacher should be aware of it.) Each new idea can be presented as an extension of an idea which is already a part of the child's understanding—not as a something entirely new.

This entire list of sequences stems from, and is dependent on, the understanding of counting. The appreciation of these dependencies leads, I believe, to reasons for the order in which topics should be introduced to the learner in elementary arithmetic.

Up to the present time, I have tried to say that children will be aided in becoming self-reliant learners of arithmetic (1) if their teachers observe in their teaching the fact that the beginnings of arithmetic are memorized learnings and should be taught with a rich associational background (this involves distinguishing the memorized from the logical learnings); and (2) if their teachers appreciate the logical arrangement of arithmetical topics and guide their children into seeing how one topic opens the way into another. If self-reliance has been developed, that in itself is contributive to confidence. But the child who is confident in his arithmetic has also two other charac-

teristics: (1) he is able to give automatic responses to facts, and (2) he knows when to use the various arithmetical operations.

The development of these abilities means that practice—much practice—drill—must be provided; it means that many opportunities must be provided—thru games, activities—for the learner to give and to use the correct responses. It means that arithmetic must be taken out of a text and put into the lives of the children. Or, better, see that it starts from a something outside of a book. It means that many every-day applications must be made. From a mathematical and pedagogical standpoint, it means that a teaching cycle will have been completed: that is, the teaching of number began with concrete experiences, those associations matured to the place where abstract number had meaning; now applications take the learner again to concrete experience. Surely seeing that arithmetic really works in every-day affairs is one way of giving children confidence in their arithmetic.

Summarizing, it has been suggested that confident, self-reliant learners in arithmetic can be assisted in their development by

1. teaching meaningful associations of terms, and recognizing the laws commonly accepted for the use of these terms.
2. teaching relationships which are the logical outgrowth of the application of these laws
3. teaching for sure and immediate responses to facts
4. teaching the use of arithmetic in every-day affairs

Again referring to Emerson and his essay on *Self-Reliance*, he says, "Welcome evermore to gods and men is the self-helping man. For him all doors are open." Applied to learner in arithmetic, it might be said, "Welcome evermore to teachers and parents, and to all civilization, is the self-helping child. For him, the doors to quantitative thinking are open; for him, arithmetic is a system of related events, a system whose applications are a part of everyday living. Welcome evermore is the child who has been guided by an understanding teacher to be self-reliant, and confident."

AFRICAN FISH HAVE ODD DIET; WILL EAT ONLY FISH SCALES

An African fish has exhibited a very odd diet. It eats only fish scales.

Unlike its American cousin, the sunfish, which will even nibble at white bread small boys often use for bait, these African species turns up its nose at earthworms, fish powder and insects in favor of plain fish scales from other living fish. The eating habits of several Tanganyika Cichlids were observed and reported to the British scientific journal, *Nature*, by G. Marlier and N. Leleup of the Tanganyika Laboratory at the Institute for Scientific Research in Central Africa, Uvira, Belgian Congo.

The scientists stated that the fish, when it succeeds in attacking another fish, pushes its mouth against the back of its victim and removes the scales. It is hoped that continued study of the fish will solve some of the mystery as to the origin and reasons for this peculiar diet.

THE TRAINING OF MATHEMATICS TEACHERS

MARC A. LAFRAMBOISE
University of Detroit, Detroit, Mich.

In a recent lecture at the symposium on Teacher Education in mathematics, in Madison, Wisconsin (7/27/52), and delivered by Professor C. C. MacDuffee, of the University of Wisconsin,[1] the speaker deplored the very spotty preparation in mathematics of most of their freshmen.

This would lead to the question of what is expected of a high school graduate in the way of mathematics, and also what is expected in the way of knowledge on the part of the high school teacher of mathematics.

In the final report of the Joint Commission of the Mathematical Association of America, and the National Council of Teachers of Mathematics,[2] the general question of mathematics in the secondary program was considered. Specific mathematics courses for each of the four high school years were recommended. These suggestions range from topics in arithmetic and elementary mathematics for the lower grades to topics in college algebra and calculus for the better senior students.

Would it be striking at a root of the problem of student preparation to require the high school teachers to be of high academic calibre since these teachers, it is presumed, would radiate confidence and enthusiasm to a degree that would make them trusted and admired teachers? Undoubtledly such teachers would encourage all students to study some mathematics.

The time to require excellent academic preparation in mathematics could well be during the undergraduate years. Many teachers attend summer sessions, but elect easy and easily-digested courses in education, rather than substantial subject matter courses to better their academic qualifications.[3]

If the undergraduate training leaves something to be desired, there is an understandable reluctance on the part of the teachers to undertake difficult courses during the summer, more especially when no specific recommendations are made regarding courses to be attempted at these summer sessions.

Teachers render invaluable service to the community which they serve, and a teacher's influence is often felt long after youth has left school. In view of the importance of the teacher's position, should it be unreasonable to expect a very good preparation even though this

[1] *Am. Math. Monthly*, vol. 60, No. 6, June-July, 1953.
[2] 15th Year Book. National Council of Teachers of Mathematics, pp. 86–119.
[3] C. C. MacDuffee, *Am. Math. Monthly*, Vol. 60, No. 6, June-July, 1953.

might imply the possibility of lengthening the period of such preparation.

A choice seems to present itself between high undergraduate academic excellence, followed by summer sessions of specialized and graduate education courses or else a fair undergraduate preparation in subject matter taken concurrently with a certain amount of education work and with the implication that it would be desirable for the teacher to complete, at some future date, a master's degree in the subject taught.

It would seem advisable and more certain to require good academic training during the undergraduate years, since B. A. Sueltz,[4] in his survey of teachers of secondary mathematics, arrived at the conclusion that mathematics teachers take professional subjects in preference to academic subjects during the summer sessions anyway.

In a report to the Illinois section of the Mathematical Association of America[5] (5/9/53), a Committee on the Strengthening of Mathematics Teaching said, "On the undergraduate level, the segregation of prospective teachers into colleges of education with a consequent emphasis on courses in 'education' is a mistake. Experienced elementary and secondary teachers should play the maximum possible part in the professional training of the prospective teacher. We believe that specialization in education as a major subject should be reserved to the graduate levels." It would appear that attention should be paid to the academic program first and then the professional program next.

It is not here suggested that all future mathematics teachers be required to take the same courses everywhere, and with the same regimentation. It seems of advantage, however, to wish for some slight agreement as to the minimum core of mathematics knowledge in the possession of the high school teacher.

In the Fourteenth Year Book of the National Council of Teachers of Mathematics,[6] the academic qualifications of mathematics teachers are discussed. Again, in the Fifteenth Year Book[7] of the N.C.T.M., courses in mathematics are suggested for two types of teachers:

(a) the teacher of mathematics and a second subject, and
(b) the teacher of mathematics alone.

For the first type, the minimum program includes courses through calculus with scientific training in geometry and algebra and some work in finance and statistics.

[4] Sueltz, Ben A, "The Status of Teachers of Secondary Mathematics in the U.S." Cortland, N.Y.
[5] *Am. Math. Monthly*, Vol. 60, No. 9, Nov. 1953, p. 652.
[6] "The Training of Mathematics Teachers," pp. 191–193.
[7] "The Place of Mathematics in Secondary Education," pp. 201–203.

For the second type, the recommendations include, in addition to the preceding, advanced calculus, differential equations, or mechanics, additional work in geometry—say projective, some modern algebra, and more of physics, chemistry, and astronomy, and all this on the undergraduate level.

The writer has himself engaged in the teaching of mathematics for some years, the greater part of them at the senior high school and junior college level. As a stimulant to thought and study, a suggested list of courses has been set down as food for thought in the training of prospective teachers of secondary mathematics. These courses are for the second type of teacher, namely the teacher of mathematics alone. In substance, this program is a regular liberal arts program with a mathematics major.

In what follows, the school year is the usual one of two semesters, each of at least sixteen weeks duration. A course will be understood to consume three class hours weekly for a total of fifty classes or so per term.

Freshman Year

1st semester		*2nd Semester*	
Hrs. Weekly		*Hrs. Weekly*	
3 College Algebra (Usual Topics)	50 hrs.	3 Analytic Geometry (Through Eq. of 2nd degree)	50 hrs.
2 College Trigonometry	34 hrs.	2 Sol. Geom. & Spherical Trig.	34 hrs.
Plus 12 hours of electives A sample election		Plus 12 hours of electives A sample election	
3 English (Literature & Composition)	50 hrs.	3 English (Literature & Composition)	50 hrs.
3 French or German (Ability to read math works)	50 hrs.	3 French or German (Ability to read math works)	50 hrs.
3 Physics (Fundamental principles)	50 hrs.	3 Physics (Fundamental principles)	50 hrs.
3 Chemistry (Fundamental theories)	50 hrs.	3 Biology (General)	50 hrs.
17 hrs. plus lab.		17 hrs. plus lab.	

Sophomore Year

1st Semester		*2nd Semester*	
Hrs. Weekly		*Hrs. Weekly*	
4 Differential Calculus	67 hrs.	4 Integral Calculus	67 hrs.
3 Analytic Geometry (Through Quadric Surfaces)	50 hrs.	3 Theory of Eq. & Determinants	50 hrs.
Plus 9 hours of electives A sample election		Plus 9 hours of electives A sample election	
3 Physics or Chemistry or Biology or Accounting, plus lab.	50 hrs.	3 Physics or Chemistry of Biology or Accounting, plus lab.	50 hrs.
3 English (The English Novel)	50 hrs.	3 English (American & Canadian Literature)	50 hrs.
3 History (Ancient & Mediaeval)	50 hrs.	3 History (Modern)	50 hrs.
16 hrs. plus lab.		16 hrs. plus lab.	

JUNIOR YEAR

1st Semester		*2nd Semester*	
Hrs. Weekly		*Hrs. Weekly*	
3	Advanced Calculus 50 hrs.	3	Advanced Calculus 50 hrs. (Through Power & Fourier Series)
3	Differential Equations 50 hrs.	3	Mechanics 50 hrs. (2-Dim Statics & Dynamics)
Plus 9 hours of electives A sample election		Plus 9 hours of electives A sample election	
3	Psychology 50 hrs.	3	Moral Phil. & Theol. (for Christians) or 50 hrs. A Study of the World's Religions (for non-Christians)
3	Probability & Statistics 50 hrs.	3	Probability & Statistics 50 hrs.
3	Economics 50 hrs. (Economic Geog. & Hist.)	3	Political Science 50 hrs. (Gov't. Political Thought International Relations)
15 hrs.		15 hrs.	

SENIOR YEAR

1st Semester		*2nd Semester*	
Hrs. Weekly		*Hrs. Weekly*	
3	Advanced Algebra 50 hrs. (Matrix Algebra, Number & Group Th.)	3	Advanced Algebra (Continued) 50 hrs. (Matrix Algebra, Number & Group Th.)
3	Modern Synthetic College Geometry 50 hrs. or Math. of Investment & Calculus of Fin. Diff. (Actuarial)	3	Projective Geometry or Theory of Life Contingencies 50 hrs. (Actuarial)
Plus 6 hours of electives A sample election		Plus 6 hours of electives A sample election	
3	Economics 50 hrs. (Money, Banking & International Trade)	3	Political Science 50 hrs. (The Politics of Democracy)
3	History of Mathematics 50 hrs.	3	Astronomy & Navigation 50 hrs.
12 hrs.		12 hrs.	

Preparation for comprehensive examinations.

A NOTE ON "THE TRAINING OF MATHEMATICS TEACHERS"

CECIL B. READ
Mathematics Editor

Mr. Laframboise suggests a program which might well be an objective to be worked for; it is doubtful if ten per cent of secondary school teachers and junior college instructors of mathematics who are presently teaching have this strong a background in pure mathematics. Nevertheless, if enough demand for stronger training becomes evident, we may eventually obtain such improved training.

The program is apparently the opinion of one individual, it may be worth while to compare it with courses suggested by over four hundred teachers of mathematics, including over one hundred heads of college mathematics departments [SCHOOL SCIENCE AND MATHEMATICS, pp. 611–619, November, 1949]. Mr. Laframboise places as required work in his program some courses which were at the bottom of the list of composite opinions, he makes elective other courses considered of greater value. Obviously differences of opinion can be expected; the important thing is to keep the issue before the public.

A PROPOSED TRIP—A TEACHING TECHNIQUE

HERBERT J. SCHIFF
Gage Park High School, 5630 S. Rockwell, Chicago, Ill.

A proposed trip to Mexico accidentally resulted in a teaching aid for a math class. Here's how it happened!

I received a packet of literature about Mexico from a large metropolitan newspaper. Among the sheets of information was a metric conversion card for the speedometer and gas gauge of a car. Since Mexico (and many other countries) use the metric system, it is necessary to interpret the speed limit signs and compute the quantity of gas for which the tourist is charged. The conversion card was also accompanied by a circular chart for changing pesos into dollars and vice versa.

As soon as these cards were examined the thought occurred that they could be used in general mathematics classes, or "essential mathematics" classes as they are called in Chicago. The card could serve several purposes.

1. Drill or review of decimal multiplication (or division).
   Since 1 kilometer = .62 miles, the conversion of kilometers per hour to miles per hour would involve multiplication by .62. Similar multiplication would be necessary for conversion of liters to gallons, and dollars to pesos.
2. Use in metric system topics.
   The study of the metric units might be enlivened by such conversions.
3. Practice on the slide rule.
   This would involve multiplying one number by many different numbers. In any event, the speedometer and gas gauge drawn on paper and the converted units computed and inserted.

A chart can be prepared for the peso-dollar conversion, with as many drill items as necessary by increasing the number of conversions. Word problems can also be invented, both by the teacher and student, such as the following:

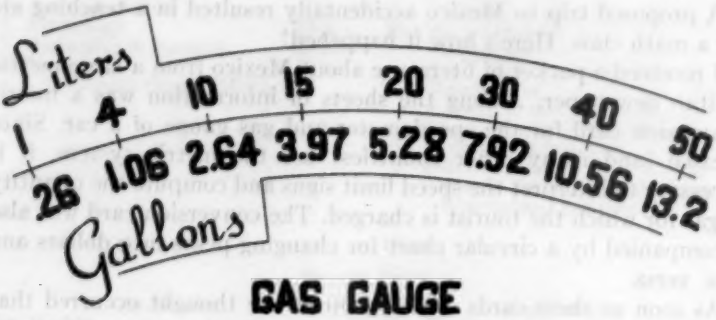
a. "If a man, driving on the Nogales highway, passes a speed limit sign reading, 45 kilometers, what should his speedometer register to keep within the law?"
b. "A couple is on the road to Mexico City. A service station attendent tells them they will need at least _____ liters of gas to get to Mexico City. Will they have to refill again if their tank holds _____ gallons?"
c. "A sale of silver trays show a reduction from 85 pesos to 65 pesos. What was the final price in dollars? How much was the reduction?"

In my own class a display was also made, using a map background with a sample of Mexican currency, pictures of speed signs and conversion problems.

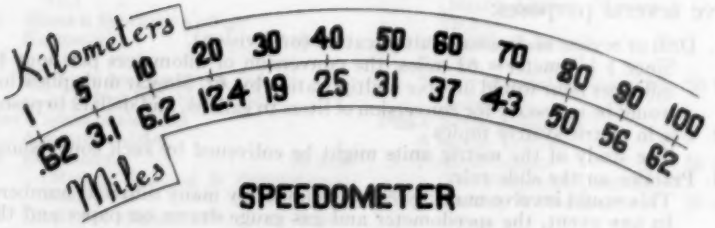
I do not wish to convey the impression that this represents a major unit. It is simply an elaboration on the possibilities of using ordinary materials for improvement of instruction. There are literally thousands of possibilities for motivation and enlivening the ordinary curriculum.

Judging from my own class, motivation and interest will be high with such an approach to the study of decimals.

P.S. I never got to Mexico!



GAS GAUGE



SPEEDOMETER

Peso-Dollar Exchange

1	2	3
$	INDEX	PESOS
.12	1	8.60
.23	2	17.20
.35	3	25.80
.47	4	34.40
.58	5	43.00
.70	6	51.60
.81	7	60.20
.93	8	68.80
1.05	9	77.40
1.16	10	86.00
1.28	11	94.60
1.40	12	103.20
1.51	13	111.80

For dollars to pesos, read from column 1 to 2 or from column 2 to 3.

For pesos to dollars, read from column 3 to 2 or from column 2 to 1.

AN ALGEBRA SLIDE RULE

CARL H. DENBOW
Ohio University, Athens, Ohio

A fifty-cent slide rule and a roll of masking tape can be converted into an efficient instrument for introducing the ideas of algebra. The major advantages of the Algebra Slide Rule are that it stimulates interest and removes part of the fear which beginners sometimes experience.

The top and bottom immovable parts of the slide rule are covered with strips of tape, and another strip is placed on the central slide, as shown in Figure 1. A number scale, in inches or centimeters or other unit, is drawn on the upper tape, with the zero point inset a little from the left end. Another scale, with unit one half as large, is drawn on the lower tape.

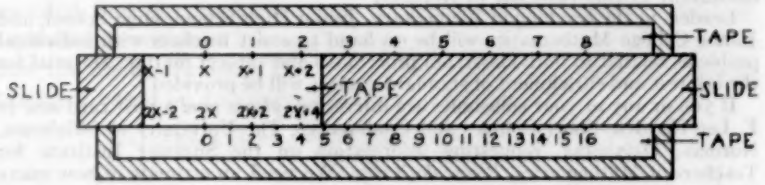


FIG. 1.

Two matching scales are drawn on the tape on the central slide. The upper one is labelled $X-2$, $X-1$, X, $X+1$, etc., and the lower one $2X-4$, $2X-2$, $2X$, $2X+2$, etc. (The intermediate marks are not labelled in Figure 1.)

We use the Algebra Slide Rule first in direct problems such as: find $2X+4$ when the *variable* X is 2, (preceded, probably, by a brief discussion of the importance of variables in everyday affairs and the importance, therefore, of learning to add 4 to a variable, multiply a variable by 2, etc.). We move the central slide until the point marked X is at 2; then $2X+4$ will be at 8.

After a few direct problems, we are are ready for inverse problems, (those in which we must undo the indicated operations). In these problems X is an *unknown*, not a variable. For example, let us find the X for which $X-2=3$, or the X for which $2X+4=8$. This latter problem has the same slide rule setting as the direct problem of the previous paragraph.

The alert pupil will be led to see that the fixed scales can be extended to the left by means of negative numbers. He may also wish to construct a slide rule with a $3X$ scale; or with an $X/2$ scale, for solving equations such as $X/2-1=\frac{1}{2}$.

The writers' experience indicates that the duller pupil, in learning to solve simple linear equations by devices of this kind, loses his fear of the abstract by seeing it in a concrete embodiment—and he learns the "undoing processes" so that he can soon solve equations such as $4X-2=10$ by logic alone.

SUMMER MATHEMATICS INSTITUTE

The *1955 Summer Institute for Teachers of Mathematics* will be held in air-conditioned classrooms at the University of Oklahoma in Norman, Oklahoma, from June 6 to June 17. Teachers may attend either week (one hour credit) or both weeks (two hours credit). The fee is $15 for one week (either week), or $25 for two weeks—either credit or non-credit. Official certificates of attendance will be issued. Dormitory accommodations are available at $2 per night or $10 per week.

Dr. Kenneth E. Brown, Specialist for Mathematics. U. S. Department of Health, Education and Welfare, Washington, D. C., will be a lecturer and staff consultant at this Institute in Norman.

Leaders in the teaching of Elementary, Junior High School, High School, and Junior College Mathematics will be on hand to assist teachers with individual problems related to both classroom procedures and subject matter. Material for the interest and enrichment of standard courses will be provided.

If you or any of your colleagues are interested, *please send* a post card *now* to F. Lee Hayden, Short Courses and Conferences, The University of Oklahoma, Norman, Oklahoma, requesting information on the Summer Institute for Teachers of Mathematics. *Please do it now.* We need an estimate of how many teachers may attend.

SEXES DIFFER IN RISK OF HEART DISEASE DEATH

A newly found difference between the sexes is announced by the National Heart Institute, U. S. Public Health Service, and the American Heart Association here.

The difference is in the risk of dying from heart and blood vessel disease. For middle-aged men this risk has gone up nearly 25% in the past generation, while for women in the same age group it has gone down by about the same amount.

These opposite trends in the heart disease death rate of men and women between the ages of 45–65 are among the new information to be found in the 1954 revision of the statistical handbook, "Diseases of the Heart and Blood Vessels—Facts and Figures."

NEW YELLOW NECTARINE RECEIVES PLANT PATENT

A new and distinct variety of yellow-fleshed nectarine was patented here this week.

The inventor of the nectarine tree, Frederic W. Anderson of Merced, Calif., stated that his invention is characterized by freestone fruit, which is yellow, instead of white fleshed, approximately 50% larger in size than the Stanwick nectarine which is currently marketed, and will keep better during shipping.

The new nectarine is from a tree produced from seeds crossed from the Le Grand nectarine and an unnamed yellow nectarine. Mr. Anderson was awarded plant patent No. 1,324.

THE ELEMENTARY SCHOOL SCIENCE LIBRARY FOR 1953–1954

PAUL E. KAMBLY
School of Education, University of Oregon, Eugene, Oregon

This is the eleventh yearly list of reference books for elementary school science compiled and published in SCHOOL SCIENCE AND MATHEMATICS. The purpose, like that of preceding lists, is to suggest to elementary school teachers, books that are supplementary to basic text series either for their values as sources of information or for recreational reading. Certain books, included primarily because of assumed value as recreational reading are below desired standards of good sources of science information. The sub-division topics are of no significance except as an aid in grouping the references.

The grade levels indicated are the lowest in which it is recommended that the books be used. Exact grade placement is difficult because of variations in pupil reading ability as well as differences in how the books are used. The recommendations and the brief annotations are based on an examination of each book listed.

REFERENCE BOOKS FOR ELEMENTARY SCHOOL SCIENCE[1]

Animals

(See also list of books on birds and insects)

	Grade	*Price*
Bats. By Charles L. Repper. 64 pp. '54. Morrow. Easy reading with good illustrations. Describes various kinds of bats, how they fly, where they live and how they care for the young. Emphasizes the fact that most bats are harmless.	3	$2.00
Bufo, The Story of a Toad. By Robert M. McClung. 48 pp. '54. Morrow. Bufo changes from a tadpole and struggles to stay alive as a tiny toad. His successful escapes from a number of enemies allow him to grow for three years before going back to the pond at egg-laying time.	3	2.00
Dinosaurs. By Herbert S. Zim. 64 pp. '54. Morrow. Explains the relationship between some of the dinosaurs and modern animals and how scientists have pieced together the story of how dinosaurs lived.	3	2.00
Here Comes the Bears! By Alice E. Goudey. 93 pp. '54. Scribners. A book divided into four parts, each an accurate story of grizzly bears, polar bears, brown bears and black bears. Beautifully illustrated and interesting reading.	3	2.25
Wide River. By Dorothy Childs Hogner. 64 pp. '54. Lippincott. A story of how small animals react to a very wet spring. Wide River overflows its banks and Little Chipmunk, Old Mole, Mr. Deer Mouse and Grandpa Chuck all must seek drier homes. Not recommended for anyone who objects to talking animals.	3	2.00
Prehistoric World. By Carroll Lane Fenton. 126 pp. '54. Day. Introduces typical animals of the past 350 million years	4	2.75

[1] Publishers and their addresses are listed at the end of this section.

	Grade	Price
through simple accurate narratives. Excellent drawings by the author.		
The First Book of Prehistoric Animals. By Alice Dickinson. 92 pp. '54. Watts. What these animals were, how they evolved over millions of years, how they lived, and how scientists learned of them.	4	1.75
The Zoo Comes to You. By Captain Burr W. Leyson and Ruth Manecke. 88 pp. '54. Dutton. Interesting stories about a number of different animals found in a typical zoo. Illustrated by excellent photographs.	4	2.95
Tree Frog. By Paul McCutcheon Sears. 46 pp. '54. Holiday. Accurate text and illustrations on the life cycle of the tree frog. Interestingly written for children. Also included are instructions on how to find and raise tree frogs as pets.	4	2.00
Gray Squirrel. By Joseph W. Lippincott. 124 pp. '54. Lippincott A story about Gray Squirrel, his adventures in growing up, his learning to survive the menace of guns and dogs, as well as the difficulties of winter.	5	2.00
Pets. By Frances N. Chrystie. 260 pp. '54. Little, Brown. A complete handbook on the care, understanding and appreciation of all kinds of animal pets. A good book for children, but is also good for parents and teachers to use in helping children learn about animals.	5	3.50
Striped Coat the Skunk. By J. W. Lippincott. 127 pp. '54. Lippincott. Striped Coat is an unusually marked skunk who grows in size and knowledge and teaches a farmer that skunks can be valuable as well as friendly neighbors.	5	2.00
The Porcupine Twins. By Jane Thompkins. 121 pp. '54. Lippincott. Porky and Pudgy, the twins, have to learn how to climb trees, how to strip bark from the trunks, how to avoid being caught by enemies and how to use quills in self-defense.	5	2.50
Animal Control in Field, Farm and Forest. By W. Robert Eadie. 257 pp. '54. Macmillan. The author is an international authority on injurious mammals and brings together here much information on the control of mammals which cause damage. While he explains the use of poisons and traps, his emphasis is on natural means of control by which populations in the wild are kept in proper balance.	6	3.75
Animals in Armor. By Clarence J. Hylander. 203 pp. '54. Macmillan. Answers such questions as "What kinds of reptiles live in my part of the United States?", "Where do most reptiles make their homes?", "What do they eat?", "Which ones are poisonous?", and "Which ones are good pets?"	6	3.50
Haunt Fox. By Jim Kjelgaard. 219 pp. '54. Holiday. A wildlife story of a red fox, of a boy and a dog who hunted him, and of the wilderness where it happened.	6	2.50
Horses and Their Ancestors. By William A. Burns. 62 pp. '54. Whittlesey. A book about horses, from their origin to the present. Tells how horses have served men throughout history—in transportation and in war, in racing and sports. The story includes the horse in art, legend, music and literature.	6	2.75
Paws, Hoofs, and Flippers. By Olive L. Earle. 192 pp. '54. Morrow.	6	3.50

	Grade	Price
This book separates the orders of mammals according to the types of feet they have. Using their claws, hoofs, flippers, and nails to classify them, the author gives the significant facts, as well as many unusual and interesting details, about every order of mammal.		
The Phantom Deer. By Joseph W. Lippincott. 192 pp. '54. Lippincott	6	3.00
An unforgettable story of a gallant miniature deer on the Florida Keys. The man Hickey lived on the Big Pine Key and raised the deer from a fawn to a handsome, courageous buck. Many exciting incidents of his struggle for existence until the government set up the Keys as a wild-life refuge.		
Zoo Expeditions. By William Bridges. 256 pp. '54. Morrow	6	3.50
Tells about seven expeditions of the New York Zoological Society which were sent out to capture wild animals.		
Birds		
Wheel on the Chimney. By Margaret Wise Brown. 30 pp. '54. Lippincott	1	3.00
A story of storks and their migration. Beautifully illustrated.		
Pete the Parakeet. By Irma Simonton Black. 97 pp. '54. Holiday	3	2.50
An excellent story of a popular bird pet. Pete becomes lonely and quits talking in a home where the people are gone much of the time. Under a little boy's loving care he talks again and is happy.		
Birds and Their World. By Carrol Lane Fenton, and D. C. Pallas. 95 pp. '54. Day	5	2.75
An introduction to many different birds and the lives they lead. It tells about North American birds and also birds from other countries.		
Bubo, The Great Horned Owl. By John and Jean George. 184 pp. '54. Dutton	5	3.00
A dramatic story of a great horned owl and his mate. Gives insight into the lives of birds of prey and helps develop an understanding of the balance in nature. Beautifully illustrated.		
Conservation		
David's Ranch. By Don Wilcox. 62 pp. '54. Messner	4	1.60
An everyday science story—a western. Presents in a vivid way some of the necessary measures for combating soil erosion. Good information on soil conservation and flood control.		
The First Book of Conservation. By F. C. Smith. 68 pp. '54. Watts	4	1.75
An imaginatively written account of how rivers, lakes, forests, wildlife, the green growing plants, and the earth, all depend on nature's intricate interrelationships.		
General Science		
Let's Look Under the City. By Herman & Nina Schneider. 69 pp. '54. William R. Scott	3	2.00
Revised edition. A primer of public utilities. Useful supplementary book for both science and social studies because there is an underlying theme of cooperation. Illustrations children will enjoy.		
Not Only for Ducks—the story of rain. By Glenn O. Blough. 48 pp. '54. Whittlesey	3	2.25
Mike learns how important rain is to all living things. Includes		

	Grade	Price
the story of frogs, toads and crayfish raising their families in the big pond made by the spring rains.		
Things Around the House. By Herbert S. Zim. 32 pp. '54. Morrow This book is designed to help children understand the everyday things inside the house. The youngest readers can learn from the pictures alone. Better readers can make use of the large-type text.	3	1.75
Make Way for Water. By Eleanor Clymer. 63 pp. '53. Messner.. A dramatic story telling how a big city is supplied with water and how people in the city are dependent on the country. Explains the workings of reservoirs and functions of the Department of Water Supply.	4	1.60
The Brave Gives Blood. By Philip & Miriam Eisenberg. 62 pp. '54. Messner..... This book, one of the everyday science stories, presents important facts about blood that could serve as a background in shaping racial attitudes. It explains human blood types, the role of blood in the animal kingdom, and the essential differences between cold-blooded and warm-blooded animals.	4	1.60
The Flying Rangers. By William Reiner. 62 pp. '54. Messner..... Another everyday science story: Two boys with the model airplane hobby become deputy rangers hoping for a chance to spot fires from the air. The book includes several simple experiments and explains how airplanes work.	4	1.60
Snow. By Thelma Harrington Bell. 56 pp. '54. Viking..... Answers any question one might ask about snowflakes. Describes how they are formed, the types and sizes, how snow is helpful and dangerous to man.	5	2.50
Television Works Like This. By Jeanne and Robert Bendick. 64 pp. '54. Whittlesey..... This is a revised edition of a book first published in 1949. It now includes, in addition to the original material: information on color television, educational television and present-day alignment of networks.	5	2.25
The First Book of Photography. By John Hoke. 69 pp. '54. Watts. A very good beginners book. It shows how to take GOOD pictures, using basic, inexpensive equipment. There are explanations on developing, composition, and mounting.	5	1.75
Through the Magnifying Glass. By Julius Schwartz. 142 pp. '54. Whittlesey..... This book gives many simple experiments with a magnifying glass that will help young children understand the nature and use of many everyday materials.	5	2.50
How to Make a Home Nature Museum. By Vinson Brown. 214 pp. '54. Little, Brown..... A good book on how to arrange a collection of objects from the world of nature so they will have real meaning. Information concerning mounts and specimens, labels, molds and models, charts and drawings and background pictures.	6	2.50
Science the Super Sleuth. By Lynn Poole. 190 pp. '54. Whittlesey This has the drama of a detective story and at the same time is informative on the achievements of science in the field of crime detection. Illustrations show a number of fascinating laboratory procedures.	6	2.75
The Boy's First Book of Radio and Electronics. By Alfred Morgan. 229 pp. '54. Scribners..... This book would be useful as a reference only for the excep-	6	2.75

	Grade	Price

tional sixth grader interested in electronics. It would be extremely useful in junior high school.

Insects

Monarch Butterfly. By Marion W. Marcher. 46 pp. '54. Holiday.. 3 2.00
This is the life-cycle story of all butterflies and moths, from egg to adulthood using the Monarch as the example. Well illustrated.

Insect Fact and Folklore. By Lucy W. Clausen. 194 pp. '54. Macmillan..... 6 3.50
By using folklore as well as facts, and by looking at the insect in its relation to man, Miss Clausen has achieved a new point of view, showing that the majority of insects are interesting, necessary, and an important part of everyday life.

Physiology

Wonders of the Human Body. By Anthony Ravielli. 125 pp. '54. Viking..... 5 2.50
An excellent book, explaining man as a walking miracle in a child's language. Drawings in two colors and the use of superimposition helps to clarify the text.

Your Wonderful Teeth. By G. Warren Schloat, Jr. 48 pp. '54. Scribners..... 4 2.25
This book tells with photographs and drawings the story of teeth and why we have them. It tells of the enemies that try to destroy teeth and how teeth can be protected.

Plants

Wait For the Sunshine. By Glenn O. Blough. 48 pp. '54. Whitlesey..... 3 2.25
A lively book with illustrated scientific information on one of the most important processes in nature—the manufacture of food by green plants.

The First Book of Cotton. By Matilda Rogers. 68 pp. '54. Watts.. 4 1.75
This book describes the busy cycle of cotton raising. It tells of the people who work with cotton, of the many machines that help in field and factory, and of some of the many surprising cotton products.

The Friendly Forests. By Alma Chesnut Moore. 96 pp. '54. Viking 4 2.50
A story of the forests from before pilgrim times. Explains the growth of trees, enemies of the forests, gifts of the forest, the uses of wood and how we can help nature replant a forest.

Cotton for Jim. By Clara Baldwin. 160 pp. '54. Abingdon..... 5 2.00
Life on a cotton plantation—from planting cotton through harvesting and to turning bales of cotton into spools of thread —seen through the eyes of 12 year old Jim.

The First Book of Plants. By Alice Dickinson. 93 pp. '53. Watts.. 5 1.75
Beginners introduction to plants of all sizes. Answers many questions about bacteria, algae, fungi, lichens, ferns, mosses, and seed plants.

Transportation

How Do You Travel? By Miriam Schlein. 24 pp. '54. Abingdon... 1 1.50
Different ways people and other animals travel—explained in simple language. Most of the page space is devoted to illustrations.

Who Built the Bridge? By Norman Bate. 40 pp. '54. Scribners.... 3 2.50

	Grade	Price
A picture story of how New Bridge was built over Big Sleepy River, the meanest river in the country.		
Here Come The Trucks! By Henry B. Lent. 95 pp. '54. Macmillan. A "how" and "why" book about twelve kinds of trucks. Contains a description of a Roadeo, in which truck drivers with safe-driving records compete for awards and prizes.	4	2.50
The First Book of Bridges. By Creighton Peet. 68 pp. '54. Watts. A clear, simple explanation of the "hows" and "whys" of bridge construction from earliest times to the present. There is a glossary of special bridge terms, and tables of information on notable modern bridges.	4	1.75
Driving Today and Tomorrow. By Margaret O. Hyde. 144 pp. '54. Whittlesey. A good book about automobiles and driving. Many fifth and sixth grade pupils will enjoy this book even though they are still too young to drive.	6	2.50
Land and Water Trails. By Ellsworth Jaeger. 227 pp. '53. Macmillan. A wealth of information and advice by a man experienced in wilderness travel both on land and water. Many illustrations by the author will help identify different animals. One chapter is devoted to "Knots and Lashings."	6	2.95

PUBLISHERS AND THEIR ADDRESSES

Abingdon: Abingdon-Cokesbury Press, 810 Broadway, Nashville 2, Tennessee.
Day: The John Day Company, 121 Sixth Avenue, New York 13, New York.
Dutton: E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, New York.
Holiday: Holiday House, 8 West Thirteenth Street, New York 11, New York.
Lippincott: J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pennsylvania.
Little, Brown: Little, Brown and Company, 34 Beacon Street, Boston 6, Massachusetts.
Macmillan: The Macmillan Company, 60 Fifth Avenue, New York 11, New York.
Messner: Julian Messner, Inc., 8 West Fortieth Street, New York 18, New York.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, New York.
William R. Scott; William R. Scott, Inc., 8 West Thirteenth Street, New York 11, New York.
Scribners: Charles Scribner's Sons, 597 Fifth Avenue, New York 17, New York,
Viking: The Viking Press, Inc., 18 East Forty-eighth Street, New York 17, New York.
Watts: Franklin Watts, Inc., 119 West Fifty-seventh Street, New York 19, New York.
Whittlesey: McGraw-Hill Company, 330 West Forty-second Street, New York 18, New York.

Snow boots made of tough, lightweight plastics can be washed inside as well as outside. Designed for children, they are available in red, white and brown. The flexibility of the plastics and a one-button fastener make it easy to peel them off without sitting down to do it.

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
Harris Teachers College, St. Louis, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, Harris Teachers College, St. Louis, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Solutions should be in double spaced typed form.

2. Drawings in India Ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known reference to it.

4. Each solution or problem for solution should be on a separate page.

In general, when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

2437, 2438, 2441, 2442. *R. L. Moenter, Fremont, Neb.*

2438. *Charles Butler, Kalamazoo, Mich.*

2442. *Burt Thomas, Ovid, N. Y.*

2442. *Elizabeth V. Warne, Gilbert, N. Y.*

2442. *Seeley J. Warne, Ridgeway, Mich.*

AN ALGEBRAIC IDENTITY

2443. *Proposed by R. G. Cawley, Dunmore, Pa.*

If $bx=ay$ and $cy=bz$ show that

$$\frac{x^n+a^n}{x^{n-1}+a^{n-1}}+\frac{y^n+b^n}{y^{n-1}+b^{n-1}}+\frac{z^n+c^n}{z^{n-1}+c^{n-1}}=\frac{(x+y+z)^n+(a+b+c)^n}{(x+y+z)^{n-1}+(a+b+c)^{n-1}}.$$

Solution by Leon Bankoff, Los Angeles, Calif.

Let

$$x/a=y/b=z/c=k.$$

Then

$$x=ak, \qquad y=bk, \qquad z=ck$$

and

$$\frac{x^n+a^n}{x^{n-1}+a^{n-1}}+\frac{y^n+b^n}{y^{n-1}+b^{n-1}}+\frac{z^n+c^n}{z^{n-1}+c^{n-1}}=\frac{(k^n+1)(a+b+c)}{k^{n-1}+1}$$

$$=\frac{(k^n+1)(a+b+c)^n}{(k^{n-1}+1)(a+b+c)^{n-1}}$$

$$=\frac{(ka+kb+kc)^n+(a+b+c)^n}{(ka+kb+kc)^{n-1}+(a+b+c)^{n-1}}$$
$$=\frac{(x+y+z)^n+(a+b+c)^n}{(x+y+z)^{n-1}+(a+b+c)^{n-1}}.$$

Solutions were also offered by Walter R. Warne, St. Petersburg, Fla., and the proposer.

A SYSTEM OF EQUATIONS

2444. *Proposed by R. G. Cawley, Dunmor, Pa.*

Solve the set:

$$ax+by+cz=0$$
$$x+y+z=0$$
$$bcx+acy+abz=xyz.$$

Solution by Leon Bankoff, Los Angeles, Calif.

By solving the second equation for y and z respectively and substituting in the first equation, we obtain

$$\frac{x}{b-c}=\frac{y}{c-a}=\frac{z}{a-b}.$$

Let

$$x=k(b-c), \qquad y=k(c-a), \qquad z=k(a-b).$$

Substituting these values in the third equation, we get

$$k[bc(b-c)+ca(c-a)+ab(a-b)]=(b-c)(c-a)(a-b)$$

which reduces to

$$k=-1.$$

Whereupon

$$x=c-b, \qquad y=a-c, \qquad z=b-a.$$

Solutions were also offered by Richard H. Bates, Milford, N. Y.; Mamie Hawkes, Romulus, N. Y.; A. R. Haynes, Tacoma, Wash.; Charles Slocum, Yale, N. Y.; Walter R. Warne, St. Petersburg, Fla.; and Leona Yerkes, Elbridge, N. Y.

THE ABSOLUTE VALUE OF A SECOND ORDER DETERMINANT

2445. *Proposed by C. W. Trigg, Los Angeles City College.*

(1) A second order determinant formed from four particular elements will have one of three absolute values.

(2) If two of the absolute values are equal, then two of the elements are equal or one is the negative of the other.

(3) If the three absolute values are equal, then three elements are equal, or two elements are equal and each is a negative of a third.

(4) If the elements are in A.P., with $d \neq 0$, one determinant is twice another, and the value of the third is independent of the smallest element.

(5) If the elements are in G.P., with $r \neq 0$ or 1, one determinant vanishes and the ratio of the other two equals $r+(1/r)$.

Solution by Richard H. Bates, Milford, N. Y.

(1) In the expansion of a second order determinant only 2 products are obtained. If the four particular elements are a, b, c, and d, then the products can only be: $|ab-cd|$, $|ac-bd|$, or $|ad-bc|$, for a can be multiplied by only b, c, or d, and the remaining product will be the product of the remaining two elements.

(2) If 2 of the absolute values are equal, with no loss of generality we assume that

$$\begin{aligned} |ab-cd| &= |ac-bd| \\ |ab-ac| &= |cd-bd| \\ |a(b-c)| &= |d(c-b)| \end{aligned}$$

hence

$$|a| = |d|.$$

(3) If the 3 absolute values are equal:

$$|ab-cd| = |ac-bd|$$

and from (2)

$$|a| = |d|$$

also

$$\begin{aligned} |ab-cd| &= |ad-bc| \\ |ab-ad| &= |cd-bc| \\ |a(b-d)| &= |c(d-b)| \end{aligned}$$

hence

$$|a| = |c|$$

and

$$|a| = |c| = |d|.$$

(4) Let the elements be a, $a+d$, $a+2d$, $a+3d$; $d \neq 0$. Then the absolute values of the 3 determinants become.

$$|a(a+d)-(a+2d)(a+3d)|; \quad |a(a+2d)-(a+d)(a+3d)|; \quad |a(a+3d)-(a+d)(a+2d)|$$

or:

$$|a^2+ad-a^2-5ad-6d^2|; \quad |a^2+2ad-a^2-4ad-3d^2|; \quad |a^2+3ad-a^2-3ad-2d^2|$$

or:

$$|-4ad-6d^2|; \quad |-2ad-3d^2|; \quad |-2d^2|$$

from which it is evident that the first is twice the second and the third is independent of a, the smallest element.

(5) Let the elements be a, ar, ar^2, ar^3; $r \neq 0$ or 1. The absolute values of the 3 determinants become:

$$|a \cdot ar - ar^2 \cdot ar^3|; \quad |a \cdot ar^2 - ar \cdot ar^3|; \quad |a \cdot ar^3 - ar \cdot ar^2|$$

or:

$$|a^2r - a^2r^4|; \quad |a^2r^2 - a^2r^4|; \quad |a^2r^3 - a^2r^3|$$

or:

$$|a^2r(1-r^3)|; \quad |a^2r^2(1-r^2)|; \quad |0|.$$

The ratio of the first to the second,

$$\frac{|a^2r(1-r^3)|}{|a^2r^2(1-r^2)|} = \frac{1+r^2}{r} = r + \frac{1}{r}$$

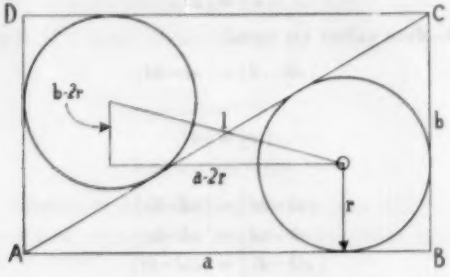
and the third determinant vanishes.

A GEOMETRY PROBLEM

2446. *Proposed by Richard H. Bates, Milford, N. Y.*

In a rectangle whose sides are a and b, a diagonal is drawn. If circles are inscribed in each triangle thus formed, find in terms of a and b the length of the line of centers.

Solution by Charles H. Butler, Kalamazoo, Mich.



$$l=\sqrt{(a-2r)^2+(b-2r)^2}.$$

To express r in terms of a and b, consider the triangle ABC with its incsribed circle O. Let

$$AC=c=\sqrt{a^2+b^2}.$$

Using the well known theorem that the diameter of a circle inscribed in a right triangle equals the sum of the two legs minus the hypotenuse, we have immediately the equation $2r=a+b-c$.

$$\begin{aligned}\therefore\quad l&=\sqrt{[a-(a+b-c)]^2+[b-(a+b-c)]^2}\\&=\sqrt{(c-b)^2+(c-a)^2}\\&=\sqrt{a^2+b^2+2c^2-2c(a+b)}\\&=\sqrt{a^2+b^2+2(a^2+b^2)-2(a+b)\sqrt{a^2+b^2}}\\&=\sqrt{3a^2+3b^2-2(a+b)\sqrt{a^2+b^2}}.\end{aligned}$$

Solutions were also offered by Leon Bankoff, Los Angeles, Calif.; Harvey Fiala, Wahpeton, N. D.; A. R. Haynes, Tacoma, Wash.; James F. Ulrich, Arlington Heights, Ill.; and Walter R. Warne, St. Petersburg, Fla.

A QUARTIC EQUATION

2447. *Proposed by Roy Wild, University of Idaho.*

Solve with skill: $x^4-6x^3+27x+17=0$.

Solution by Herbert Hannon, Kalamazoo, Mich.

By using the substitution $z=x-3/2$ this equation can be transformed into a new equation in which each of the roots has been diminished by 3/2. In the present case the effect of this transformation is to make not only the third degree term, but also the first degree term, vanish, leaving the equation $16z^4-216z^2+677=0$ which is a quadratic equation in z^2. Solution of this by the quadratic formula gives

$$z^2=\frac{27\pm2\sqrt{13}}{4}$$

or

$$z=\pm\tfrac{1}{2}\sqrt{27\pm2\sqrt{13}}.$$

Now recalling that $z=x-3/2$, this in turn gives the roots of the original equation as

$$x=\tfrac{3}{2}\pm\tfrac{1}{2}\sqrt{27\pm2\sqrt{13}}.$$

All four of these roots satisfy the original equation.

Solutions were also offered by Richard H. Bates, Milford, N. Y.; Libbie Brown, Union Hill, N. J.; Leslie V. Morris, Madison College, Tenn.; Walter R. Warne, St. Petersburg, Fla.; and the proposer.

AN ELIMINATION PROBLEM

2448. *Proposed by Roby Fretwell, Keokuk, Iowa.*

Eliminate x and y from the equations:

$$x^2y=a$$
$$x(x+y)=b$$
$$2x+y=c.$$

Solution by Leon Bankoff, Los Angeles, Calif.

Substitute $y=c-2x$ in the first two equations, obtaining

$$2x^3-cx^2+a=0 \tag{1}$$
$$x^3-cx+b=0. \tag{2}$$

Multiply (2) by $2x$ and subtract from (1), obtaining

$$x^2=\frac{2bx-a}{c}. \tag{3}$$

From (2) and (3) we obtain

$$x=\frac{a-bc}{2b-c^2} \tag{4}$$

or

$$x^2=\frac{(a-bc)^2}{(2b-c^2)^2} \tag{5}$$

Substituting (4) in (2), we get

$$x^3=\frac{ac-2b^2}{2b-c^2}. \tag{6}$$

From (5) and (6) we obtain

$$(ac-2b^2)(2b-c^2)=(a-bc)^2.$$

Solutions were also offered by Charles H. Butler, Kalamazoo, Mich.; Georgia Burroughs, Elmira, N. Y.; Harvey Fiala, Whapeton, N. D.; A. R. Haynes, Tacoma, Wash.; Harry B. Reddick, Hamilton, Canada; Nellie Shepson, Reno, Nev.; Walter R. Warne, St. Petersburg, Fla.; and the proposer.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of

the magazine in which his name appears.
For this issue the Honor Roll appears below.

2437, 2438, 2439, 2442. *Lee Dresden Goldberg, Hillside, N. J.*

2438. *John Hewett, Toronto, Canada.*

PROBLEMS FOR SOLUTION

2467. *Proposed by Howard D. Grossman, New York, N. Y.*

Prove (a) the sum of the areas of any three faces of a tetrahedron is greater than the area of the fourth face; and (b) the plane area bounded by a broken line (or curve) in a plane is the smallest area bounded by that curve.

2468. *Proposed by Brother Feliz John, Philadelphia, Pa.*

Solve the equation

$$\begin{vmatrix} 4x & 6x+2 & 8x+1 \\ 6x+2 & 9x+3 & 12x \\ 8x+1 & 12x & 16x+2 \end{vmatrix} = 0.$$

2469. *Proposed by Brother Felix John, Philadelphia, Pa.*

Solve the equation

$$\sqrt[3]{6(5x+6)} - \sqrt[3]{5(6x-11)} = 1.$$

2470. *Proposed by C. W. Trigg, Los Angeles City College.*

Find the unique permutation of the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, which is less than the square of a palindromic integer.

2471. *Proposed by J. W. Lindsey, Amarillo, Texas.*

In terms of the sides of a given inscribed triangle find the radius of a circle.

2472. *Proposed by C. W. Trigg, Los Angeles, Calif.*

Determine the magnitudes of the dihedral angles and of the polyhedral angles of a regular octahedron.

BOOKS AND PAMPHLETS RECEIVED

PHYSICS FOR OUR TIMES, by Walter G. Marburger, *Professor of Physics, Western Michigan College of Education, Kalamazoo, Michigan*, and Charles W. Hoffman, *Rocket Branch, Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland*. Cloth. 574 pages. 16×23.5 cm. 1955. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $4.48.

UNIVERSITY PHYSICS, Second Edition, by Francis Weston Sears, *Massachusetts Institute of Technology*, and Mark W. Zemansky, *The City College of New York*. Cloth. Pages viii+1031. 15×23 cm. 1955. Addison-Wesley Publishing Company, Inc., Cambridge 42, Mass. List Price $10.00. College Adoption Price $8.50.

MATHEMATICS FOR TECHNICAL AND VOCATIONAL SCHOOLS, Fourth Edition, by Samuel Slade, B.S., C.E. and Louis Margolis, A.B., C. E. Cloth. Pages ix +574. 13.5×21 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.48.

ARITHMETIC FOR TEACHER-TRAINING CLASSES, Fourth Edition, by E. H.

Taylor, *Professor of Mathematics, Emeritus, Eastern Illinois State College*, and C. N. Mills, *Professor of Mathematics, Illinois State Normal University*. Cloth. Pages ix+438. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.25.

TRIGONOMETRY, by Roy Dubisch, *Associate Professor of Mathematics, Fresno State College*. Cloth. Pages xiv+396. 13.5×20.5 cm. 1955. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. Price $5.00.

ELECTRICITY AND MAGNETISM, by Ralph P. Winch, *Barclay Germain Professor of Natural Philosophy, Williams College, Williamstown, Mass.* Cloth. Pages xii+755. 15×23 cm. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $7.75.

GENERAL SCIENCE, by Victor C. Smith, *Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota*, and W. E. Jones, *Science Department, Evanston Township High School, Evanston, Illinois*. Cloth. 504 pages. 16×22.5 cm. 1955. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

ALGEBRA ONE, by Rolland R. Smith, *Co-ordinator of Mathematics, Public Schools, Springfield, Massachusetts*, and Francis G. Lankford, Jr., *Professor of Education, University of Virginia*. Cloth. Pages vi+410. 14.5×23 cm. 1955. World Book Company, Yonkers, New York.

ANTHROPOLOGY, by J. E. Manchip White, (M. A. Cantab). Cloth. Pages viii +191. 10.5×17.5 cm. 1954. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

ALGEBRA FOR COLLEGE STUDENTS, by William M. Whyburn, *Professor of Mathematics, University of North Carolina*, and Paul H. Daus, *Professor of Mathematics, University of California at Los Angeles*. Cloth. Pages xi+290. 14×21.5 cm. 1955. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.25.

TWO EARS OF CORN, TWO BLADES OF GRASS, by D. H. Killeffer. Cloth. Pages x+139. 14.5×23 cm. 1955. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $4.00.

FUNCTIONAL MATHEMATICS, Grade 8, by William A. Gager, Dorris H. Johnson, Carl N. Shuster, Richard Madden, and Franklin W. Kokomoor. Cloth. Pages viii+373. 15×23 cm. 1955. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $2.24.

LOOKOUT FOR THE FOREST, A CONSERVATION STORY, by Glenn O. Blough, *Associate Professor of Education at the University of Maryland*. Cloth. 48 pages. 18×25 cm. 1955. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $2.25.

USING MATHEMATICS, by Kenneth B. Henderson, *Professor of Mathematics Education, University of Illinois, Urbana, Illinois*, and Robert E. Pingry, *Supervisor of Student Teaching in Mathematics, University of Illinois, Urbana, Illinois*. Cloth. Pages xvi+555. 14×21.5 cm. 1955. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $3.36.

WINGS IN YOUR FUTURE, by Leo Schneider, *Chairman, Science Department, William W. Niles Junior High School. New York City*, and Maurice U. Ames, *Principal, New York City*. Cloth. 151 pages. 13×20.5 cm. 1955. Harcourt, Brace and Company, 383 Madison Avenue, New York 17, N. Y. Price $2.75.

NEW SOLID GEOMETRY, by A. M. Welchons and W. R. Krickenberger. Cloth. Pages x+326. 13.5×20.5 cm. 1955. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.68.

GENERAL SCIENCE WORKBOOK, by Victor C. Smith, *Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota*, and W. E. Jones, *Chiarman, Science Department, Evanston Township High School, Evanston, Illinois*. Paper. 192 pages. 20.5×27.5 cm. 1955. J. B. Lippincott Company, 333 West Lake Street, Chicago, Ill.

TEXT MATERIALS IN MODERN EDUCATION, by Lee J. Cronbach, Editor, Robert Bierstedt, Foster McMurry, Wilbur Schramm, and Willard B. Spalding. Paper. 216 pages. 15×23 cm. 1955. University of Illinois Press, Urbana, Ill. Price $2.50.

THE RADIO AMATEUR'S HANDBOOK, Thirty-Second Edition, by the Headquarters Staff of the American Radio Relay League. Paper. 768 pages. 16×245 cm. 1955. American Radio Relay League, West Hartford 7, Mass. Price $3.00. in the United States, $3.50 in U. S. Possessions and Canada, $4.00 elsewhere.

ONE HUNDRED MATHEMATICAL CURIOSITIES, by William R. Ransom, *Walker Professor of Mathematics, Emeritus, Tufts College*. Paper. Pages viii+212. 20×27.5 cm. 1955. J. Weston Walch, Publisher, Box 1075, Portland, Me. Price $3.00.

SUCCESSFUL DEVICES IN TEACHING ALGEBRA, Edited by Katharine E. O'Brien. Paper. 150 pages. 20×27.5 cm. 1955. J. Weston Walch, Publisher, Box 1075, Portland, Me. Price $2.50.

SUCCESSFUL DEVICES IN TEACHING GEOMETRY, Edited by Katharine E. O'Brien. Paper. 166 pages. 20×27.5 cm. 1955. J. Weston Walch, Publisher, Box 1075, Portland, Me. Price $2.50.

MODERN PHILOSOPHIES AND EDUCATION. The Fifty-Fourth Yearbook of the National Society for the Study of Education. Part I. Prepared by the Yearbook Committee, John S. Brubacher, *Chairman*, and Others. Paper. Pages x+374+vi. 15×23 cm. 1955. The University of Chicago Press, 5750 Ellis Avenue, Chicago 37, Ill. Price $3.25.

MENTAL HEALTH IN MODERN EDUCATION, The Fifty-Fourth Yearbook of the National Society for the Study of Education. Part II. Prepared by the Yearbook Committee, Paul A. Witty, *Chairman*, and Others. Paper. Pages xi+397+lxxiv. 15×23 cm. The University of Chicago Press, 5750 Ellis Avenue, Chicago 37, Ill. Price $3.25.

COLLEGE AND UNIVERSITY PROGRAMS FOR THE PREPARATION OF TEACHERS OF EXCEPTIONAL CHILDREN, by Romaine P. Mackie, *Chief, Exceptional Children and Youth*, and Lloyd M. Dunn, *Coordinator, Special Education, George Peabody College for Teachers*. Bulletin 1954, No. 13. Pages viii+91. 15×23.5 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

EDUCATING CHILDREN IN GRADES SEVEN AND EIGHT, by Gertrude M. Lewis, *Specialist for Upper Grades*. Bulletin 1954, No. 10. Pages vii+99. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

THE EARTHWORM, by Albert Wolfson, *Associate Professor of Biological Sciences, Northwestern University*, and Arnold W. Ryan, *Scientific Illustrator*. Paper. 30 pages. 16.5×23 cm. 1955. Row, Peterson and Company, Evanston, Ill. Price $3.20.

THE FROG, by Albert Wolfson, *Associate Professor of Biological Sciences, Northwestern University*, and Arnold W. Ryan, *Scientific Illustrator*. Paper. 21 pages. 15×24.5 cm. 1955. Roe, Peterson and Company, Evanston, Ill. Price $3.20.

THE HUMAN, by Albert Wolfson, *Associate Professor of Biological Sciences,*

Northwestern University, and Arnold W. Ryan, *Scientific Illustrator*. Paper. 30 pages. 15×24 cm. 1955. Roe, Peterson and Company, Evanston, Ill. Price $3.20.

BOOK REVIEWS

APPLIED ATOMIC ENERGY, by K. Fearnside, M.A., A.M.I.E.E.; E. W. Jones, B.Sc., A. Inst. P.; and E. N. Shaw, B.Sc., Cloth. Pages viii+156, with fourteen plates (photographs) and twenty-four figures. 12.0×18.5 cm. 1954. Philosophical Library, 15 East Fortieth Street, New York 16, N. Y. Price $4.75.

This is an English report of, not atomic energy so much as, isotopes produced and their service in the researches of science. But four of its pages are assigned to attention to the peace-time use of atomic energy for power purposes. Its chief bid for this reviewer's interest is its account of what our British fellow-scientists have done while the Americans were making atomic bombs.

Seven of its eleven chapters are addressed to isotopes, their preparation, kinds, and uses in: pure research, biology, medicine, agriculture and industry. The first two chapters are background on nuclear physics and nuclear reactors and two other chapters deal with more general matters under the titles of techniques and legal aspects of atomic energy.

The plan of exposition uses many specific illustrations of the usefulness of isotopes in the fields mentioned above. Considering the brevity of its treatment it succeeds surprisingly well in clarity of its explanations. Plates and figures have legends that are helpful in their contribution. They could be placed nearer the the text which they are illustrating with better advantage to the reader. An appendix of three parts assembles tables of pertinent information for sixty-two isotopes. Both the bibliography and the index are distressingly brief from a student's point of view.

If American scientists in the field of nucleonics read this book they will be struck by two omissions; there are few references to U. S. publications in the bibliography and while there are many allusions to specific uses of isotopes, references to the source of those instances are not given. There is no chance for the reader to follow up.

B. CLIFFORD HENDRICKS
Longview, Wash.

EXPERIMENTAL COLLEGE PHYSICS, Third Edition, by Marsh W. White, *Professor of Physics, Pennsylvania State College*, and Kenneth V. Manning. *Associate Professor of Physics, Pennsylvania State College*. Cloth. Pages xii+347.16×23.5 cm. 1954. McGraw-Hill Book Co. Inc. 330 W. 42nd St., New York, 36, N. Y.

This is the third edition of a widely used laboratory manual designed for use in an introductory course in College physics. The book is printed in clear type on good stock and is permanently bound. It is not designed for the student to record his data and observations directly in the manual and is decidedly not one of the more common types of expendable laboratory guides.

The manual is divided into five main parts: (1) General; (2) Mechanics; (3) Fluid Physics, Heat, and Sound; (4) Magnetism and Electricity; and (5) Light. Each main part is subdivided into chapters, each chapter dealing with some important physical concept, law, or principle. Somewhat detailed directions for one, two, and in a few cases three experiments are given in each of the 45 chapters. Probably the chief justification for publishing this manual in a permanently bound form may be inferred from a statement in the Preface: "Each chapter includes a concise statement of the important theory underlying the experiments, descriptions of the apparatus used, and an unusually complete list of suggestive questions and problems. The directions for the actual experimental procedures are complete enough for the average thoughtful student, but a studious attempt

has been made to design steps in the manipulation of the apparatus so that the reasoning powers of the student are utilized and developed to the maximum extent."

The authors of this manual emphasize the importance of graphical methods of displaying and analyzing numerical data. They point out the necessity of evaluating the relative errors in a set of observations. They stress the value of concise and well-written laboratory reports. These goals and outcomes of laboratory work in physics are so often neglected.

The authors generally use the cgs system of units throughout the text and in the numerical data tables given in the appendix. Four-place natural sine and tangent tables are given in the appendix. A four-place logarithm table is given on the back cover pages.

The 76 experiments for which directions are given are largely of a conventional well-tested type, requiring familiar standard laboratory apparatus commonly available from supply houses. The large number of experiments listed provides ample opportunity for a teacher or student to exercise his option. Approximately one-third of the experiments are in the fields of magnetism and electricity. Approximately one-third of the experiments are in mechanics. Fluid physics, heat, light and sound together make up the remainder of the list.

This reviewer was pleased to note that the authors have adopted the term *capacitor* for the obsolescent term electric *condenser*. He was somewhat disappointed to find no mention of the ohmmeter among the electrical measuring instruments discussed, and no mention of any aspect of electronics or radioactivity anywhere in the manual. Perhaps it is intended to defer these topics for a later course in physics, but is would seem that an introductory course in laboratory physics should provide some experience in the newer, well established areas of physics.

WALTER G. MARBURGER
Western Michigan College
Kalamazoo, Michigan

TEEN-AGERS, by Gladys Gardner Jenkins, W. W. Bauer and Helen S. Shacter Cloth. 288+8 "Trans-Vision" pages. 1954. Scott, Foresman and Company, $3.60.

This is one of the newer types of textbooks appearing on the educational scene, one that is not entirely devoted to the subjects taught in most of the high schools today or in the past. It is about teen-agers, for teen-agers, a health and personal development text with special emphasis on the modern problems of 14, 15 and 16 year olds.

There are five major units, all centered about the pupil, his body, family, environment and his future. The style bears a direct personal approach to the reader. A typical situation that might occur in a phase of a teen-agers life is used for a setting. From there, many varied problems are brought up that are thoroughly discussed, analyzed and solved in a conversational free moving style that a kindly parent or understanding counselor might use. Most of the problems must be solved by the students however, directly or indirectly. The problems at the end of the chapters are presented in many ways that require thought e.g.: "What suggestions do you have to offer. . . ," "Do your agree . . . justify your opinion . . . ," "What do you think about . . . ," "Why is it important to . . . ."

Typical subjects include dating, social skills, smoking, drugs, managing time and money, education, job planning and community health.

The type is large and many styles are used on each page. At least half of each page is illustrated by diagrams, charts, sketches or cartoons in either color or black and white. The illustrator should be given much credit for making each page attractive as well as educational. There are several transparencies showing labeled parts of the human body in layers.

There are two types of activity sections, terminating the units. One requires the application of principles covered and the other entitled "Doing your own

research," which is similar to the usual listings of additional readings, trips to take, films to see and special subjects to report on.

One unusual feature is a teen-age fiction list that bears on the problems discussed in the book. Unfortunately there is no glossary, although there is a guide page for pronunciation of the most technical terms used.

Although specifically designed as a textbook for the typical High school student, the general student who might benefit most from this book might have a little trouble with the vocabulary and some of the more important sentences. The number of schools featuring courses in family living are limited at present but it might be wise if school libraries contained this type of book for the Science and Social studies teachers to use for student reference, giving them the opportunity to benefit from such a book. Many surveys were conducted in preparation for this book and much of it was used in experimental classroom situations. It could be used in a single semester course with ample time left for other activities relating to the subject.

JOHN D. WOOLEVER
Mumford High School
Detroit, Mich.

LET'S DRIVE RIGHT, by Maxwell Halsey, *Executive Secretary of the Michigan State Safety Commission.* Cloth. 496 pages. 1954. Scott, Foresman and Company, $3.48.

Another title for this book might be "How to Drive and Let Drive" because the objectives, content, logic and approach all lead to this particular theme. It is an intelligent approach to good driving, a requirement in additions to good luck which seems necessary for survival in the motor age.

It goes beyond the old rules of looking both ways and easing up on the accelerator. The first section deals with good rules and sound advice. What is important in this section is not so much the advice, as the "why of it" which is stressed. The second of the four units breaks down the parts and systems of the average automobile, using simple diagrams. Each important part is described as well as its function and relationship to other parts of the car. Although it delves into the specific parts, it is not too detailed or complex for those who are not mechanically inclined.

In addition to this, general directions are given on how to keep a car in good condition and what to do when it fails to operate properly, including how to fix a flat tire. Suggestions are given to prospective purchasers of new and used cars, the latter of which is important to many licensed teen-agers who will read this book.

The author anticipates and analyzes every conceivable problem faced by a driver from purchasing, to parking a car. It approaches each problem scientifically and leads the student to solve each problem as it should be solved, with good judgment and sound reasoning based on the simple facts as presented in an orderly fashion. It considers the reader as a pedestrian or cyclist as well as a driver. It even devotes considerable space to the student as a vacation traveler and the multitude of problems in driving to strange places. This includes proper interpretation of maps, road signs, and sightseeing.

The vocabulary and sentence structure is such that anyone who might be legally licensed should be able to understand the book. Almost every page includes a photograph, diagram, chart, cartoon or graph that relates to a specific driving situation or the problem under consideration. Problems are created for the student to solve that may exist under all circumstances. The provision of "Picture problems" is of great importance in reaching the poor reader.

The type is large and the book lacks the usual textbook appearance. At the end of each chapter there is a list of references for additional reading, discussion questions, practical problems based on preceding material and many activity projects of real value. Many authentic statistics and records are given to support

various statements made throughout the book. At the end is a glossary, even though the context of each unit is simple and self explanatory.

Fortunately citizenship training is of major consideration as indicated by the stress laid on the considerations and responsibilities of the future driver in regard to road construction, parking facilities, auto construction, driving laws, future legislation, teen-age driving habits and employment opportunities that involve a great amount of driving.

The entire book is very thought provoking. It is well organized, suitable for the High school student or adult who plans to drive or may already be driving. There has long been a need for such books and any school, public or private, contemplating a driver training program should consider examining this text.

JOHN D. WOOLEVER
Mumford High School
Detroit, Michigan

RED TREES, 100% U.S., WORKED OVER IN RUSSIA

Pure, 100% American trees, that ironically are already red, are now being subjected to Russian scientific experimentation.

The giant American redwood is being hybridized and transplanted by Russian foresters and botanists.

In "Voks," the bulletin of the U.S.S.R. Society for Cultural Relations with Foreign Countries, the Russians report that "one can already see three-year-old sequoias around Moscow."

They go on to state that this original native of North America is being grown for planting by the U.S.S.R. Forestry Research Institute, and at the same time, the Institute is conducting research in the hybridization of the giant tree, crossing it with larch, cypress and others.

Apparently, the first redwoods were brought to Russia in the 1860's, but in "tsarist Russia," the article states, they were grown exclusively to decorate parks on the southern coast of the Crimea and the Caucasus.

Now, however, Soviet scientists have tried introducing the sequoia into the forests of the Crimea and other parts of the Soviet Union. "Using Michurin's (called the Burbank of Russia) methods," the article adds, "botanists have set themselves the task of moving sequoias farther north."

The article also points out that they are called redwood trees because of the color of their bark.

INFECTED WHITE PINES SAVED BY TREE SURGERY

White pines infected with blister rust can be saved by tree surgery.

The sharp rise in the value of white pine lumber, and the cost required to replace it as an ornamental tree makes tree surgery increasingly important, report J. F. Martin of the U. S. Forest Service and G. F. Gravatt of the U. S. Agricultural Research Service.

Heretofore, the spread of the deadly blister rust was arrested through the eradication of gooseberry and current bushes, which produce the spores that transmit the infection to the trees.

Now, declare the scientists, trees already infected can be saved from destruction by using the little practiced art of tree surgery on the valuable white pines.

Especially in dense stands, tree landowners can frequently remove blister rust cankers from the forest trees through normal pruning and thinning out, they report.

Tree surgery is justified, the government scientists state, when it is not too difficult or costly. Saving the trees through surgery also means saving the time required to grow other timber trees.

THE TEACHING OF THE NATURAL SCIENCES IN RELATION TO RELIGIOUS CONCEPTS

A Seminar Workshop for College Teachers
The Pennsylvania State University
July 10–23, 1955

Because of the growing concern over the apathetic attitude to religion developed by students as they study science, the Danforth Foundation will sponsor for the third year a seminar workshop on "The Teaching of the Natural Sciences in Relation to Religious Concepts." The sessions will be from July 10 through 23, 1955 on the campus of The Pennsylvania State University.

College teachers of science will attack problems incident to the teaching of the natural sciences in relation to religious concepts. With a growing concern about this relationship, there has come a realization of a progressively greater need for teachers to concern themselves with religious interpretations of reality and of all human experiences. This need is present for all faiths and in all disciplines and instructional areas.

Dr. William G. Pollard, distinguished physicist and executive director of the Oak Ridge Institute for Nuclear Studies, again will be one of the Seminar leaders and lecturers. He is an experienced, successful teacher and research worker. Recently he was ordained to the Christian ministry, after several years of theological studies, carried on while directing the work of the Institute at Oak Ridge. Dr. Pollard's morning lectures and discussions will deal with "Scientific and Religious Categories of Thought" and his evening series with "The Judeo-Christian Tradition." His major themes will be the interpretation of the natural sciences and religion and their interrelations, a consideration of the nature of physical and spiritual reality, the historical development of religious concepts and insights—especially in the Judeo-Christian tradition, the application of religious principles to the analysis of our contemporary culture and modes of thought.

A lecture and discussion regarding "Educational Issues and Teaching Problems —Strategy and Tactics" will feature the second part of each morning's session. Dr. Harold K. Schilling, Professor of physics and dean of the Graduate School of The Pennsylvania State University, will deal with these matters and will consider both curricular and extra-curricular aspects of teaching. Dean Schilling, who has had many years of experience as a college teacher and administrator, has gained national recognition by his research in ultrasonics and acoustics. In his lectures Dr. Schilling will endeavor to develop a point of view on the task of the Christian teacher, identify and analyze teaching problems in the area of the relations between the natural sciences and religion, and suggest appropriate teaching techniques and materials.

The director of the seminar will be Dr. W. Conard Fernelius, professor of chemistry and head of the Department of Chemistry at The Pennsylvania State University, who has had many years of teaching and industrial experience and is a leader in chemical education.

A typical day will include two lecture-discussion periods in the morning and one in the evening. Afternoons will be devoted to study, group discussions, personal conferences with the leaders and recreation. All registrants will eat and be housed as a group. Members of the seminar will eat together at noon and in the evening. The cost of the conference, including meals and lodging, for the two weeks will be $95.00; Danforth scholarships in this amount will be available for twenty-five qualified registrants who apply before May first.

A minimum of three years of experience in teaching college courses in the natural sciences or mathematics is required for admission. It is hoped especially that younger staff members will attend in numbers since their longer period of future professional activity will be maximally rewarding from the viewpoint of the sponsors. Registrants who are eligible and meet certain requirements may earn two graduate semester hour credits.

Complete information about the program is available upon request to Dr. W. Conard Fernelius, The Pennsylvania State University, State College, Pennsylvania.

THE "WHY I TEACH" CONTEST

The American Legion Auxiliary announces its 1954–55 contest for teachers, entitled "Why I Teach."

The purpose of the contest is to encourage eligible young men and women to enter the teaching profession.

A contestant must have completed five years of teaching by June 1, 1955, The essays must be of not less than 250, and not more than 300, words.

There will be divisional awards of a $50 United States savings bond to the contestant having the winning entry in each of the five divisions. A national award of a $250 United States savings bond will go to the one of the five divisional winning contestants.

Mrs. J. Pat Kelly of Birmingham, Alabama, National Security Chairman of the American Legion Auxiliary, has announced that the date of the contest is from December 1, 1954 to midnight of June 1, 1955.

All entries are to be sent to the national headquarters of the American Legion Auxiliary, 777 North Meridian Street, Indianapolis 7, Indiana.

FIVE BILLION YEARS AGE METEORITES AND PROBABLY EARTH

Meteorites, the earth's only imports from outer space, are as old or older than the earth they smash into. They are about 5,000,000,000 years old, with the minimum age of the earth itself about 4,500,000,000 years.

This was determined by Gerald J. Wasserburg of the University of Chicago's Institute for Nuclear Studies and Richard J. Hayden of Argonne National Laboratory, who reported to the American Physical Society they had dated two meteorites by measuring the ratios of atoms of radioactive potassium 40 to atoms of the inert gas, argon 40, within them.

The new measurements showed that two meterorites solidified 4,860,000,000 and 4,700,000,000 years ago.

The datings strengthen the idea that both meteorites and earth were formed about the same time.

ACTIVATED CARBON MADE FROM PEANUT SHELLS

Activated carbon, an extensively used purifying agent, can now be produced from peanut shells.

The porous black substance which is used as a filter in gas masks and to decolorize such substances as cane sugar was produced by powdering the peanut hulls and heating them in a steel rotary kiln.

A dry yield of 34.9% was reported when the hulls were carbonized at 300 degrees Centigrade for an hour, then activated with steam in the same kiln at 700 degrees Centigrade for two hours. The hulls were first treated with ammonium phosphate. Without this added chemical, yields dropped to 26.9% and an inferior product was obtained. The scientists found that powdering the hulls increased the power of the activated carbon to attract, or adsorb, impurities.

The work was reported by Frank C. Vilbrandt, professor of chemical engineering, and his associate, Stephen M. Gano to the Virginia Polytechnic Institute.

SELF-PROPELLED, PLASTIC BARGE BUILT FOR ARMY

A new self-propelled plastic barge which can be dismantled and moved by airplane has been developed.

The craft is 51 feet long, and is believed to be the largest reinforced plastic structure ever built. It weights 10.2 tons and settles only 21 inches in the water when carrying a load of five tons. The barge is powered by two 165-horsepower

diesel engines and can push a fleet of non-powered barges carrying cargoes of up to 100 tons.

The hull is constructed of phenolic impregnated cotton duck sandwiched between two sheets of plastic reinforced by glass fiber. It was molded in a large plywood form.

When the masts and searchlights are retracted the barge, built by the Englander Company, Plastics Division, Baltimore, will pass under bridges having a minimum clearance of eight feet.

The craft is designed for the Army Transportation Corps as a light craft to ship supplies to troops over shallow and restricted waterways.

UNIVERSE'S BIGGEST STAR 200,000 TIMES SUN'S SIZE

The largest star yet found in the far flung universe is 200,000 times the diameter of our sun, Dr. Armin J. Deutsch of Mt. Wilson and Palomar Observatories reported to the Astronomical Society of the Pacific meeting jointly with the American Association for the Advancement of Science at Berkeley.

This object is one of the show stars of astronomy, Alpha Herculis, visible to the naked eye, but so complex that telescopes, spectrometers and interverometers are needed to show its true nature.

Dr. Deutsch found that both the main star and double star companion are immersed in an immense cloud of intensely cold gas, making this aggregation a record for size.

The gas which is close to absolute zero in temperature is being ejected from the star system at such a rate that it loses a mass equal to that of our sun in 4,000,000 years, which is very speedy loss the way time is measured in the universe.

This immense star aggregation is relatively close to us since Dr. W. P. Bidelman of Lick Observatory finds that it takes light 1,200 years to travel from it to earth.

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